FEBRUARY 27, 1959

electronics

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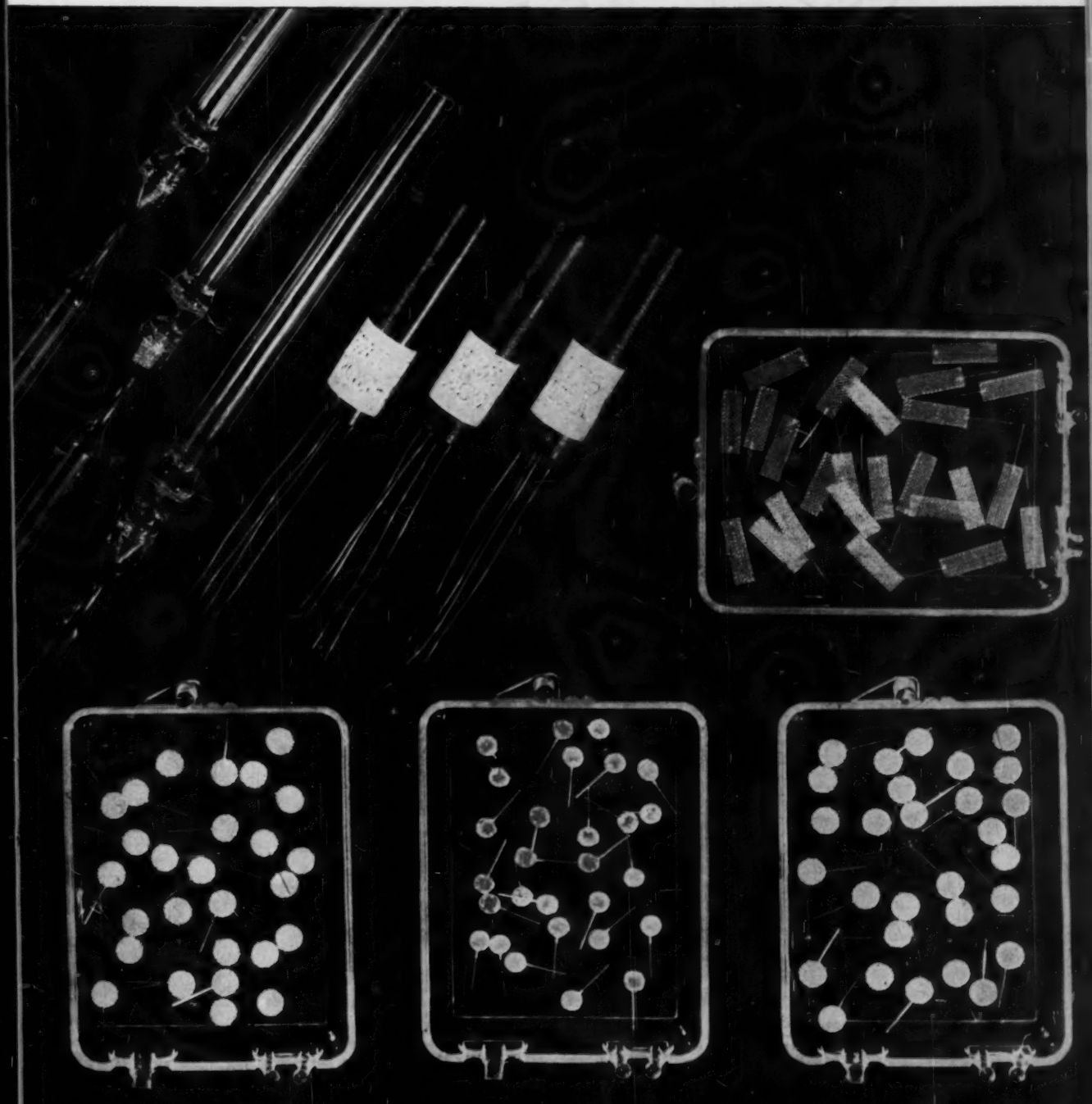


Worldwide Air Navigation-Aid Debate

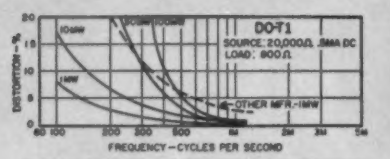
TO MAKE YOUR EQUIPMENT *SMALLER YET MORE RELIABLE*

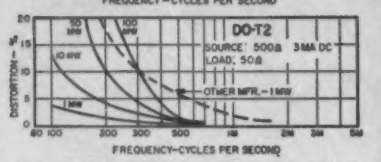
REVOLUTIONARY TRANSISTOR* TRANSFORMERS, HERMETIC TO MIL-T-27A

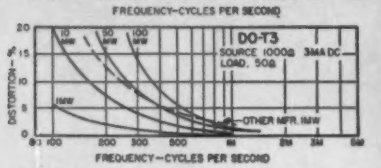
Conventional miniaturized transistor transformers have inherently poor electrical characteristics, perform with insufficient reliability and are woefully inadequate for many applications. The radical design of the new UTC DO-T and DI-T transistor transformers provides unprecedented power handling capacity and reliability, coupled with extremely small size.

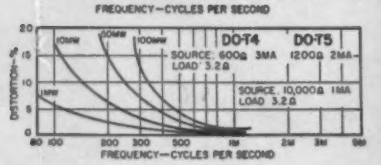
TYPICAL DO-T PERFORMANCE CURVES

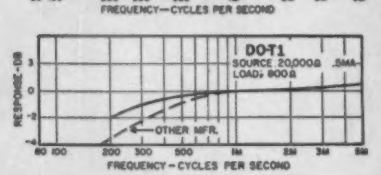
Power curves based on setting output power at 1 KC, then maintaining same input level over frequency range.

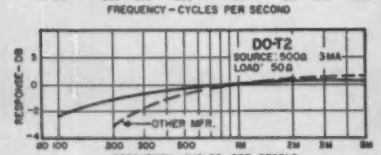


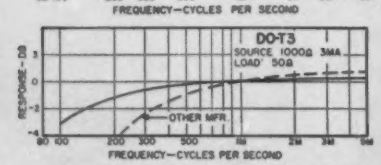


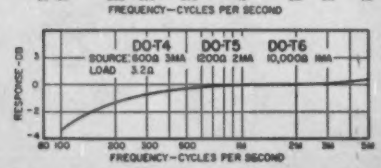












DO-T

High Power Rating . . . up to 100 times greater.

Excellent Response . . . twice as good.

Low Distortion . . . reduced 80%.

High Efficiency . . . up to 30% better.

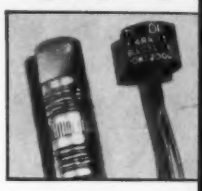
Moisture Proof . . . hermetic to MIL-T-27A.

Rugged . . . completely cased.

Anchored Leads . . . will stand 10 lb. pull, plastic leads for printed circuits.

5/16 Dia. x 1 13/32, 1/10 Oz.

DI-T



5/16 Dia. x 1/4, 1/20 Oz.

To fully appreciate DO-T transistor transformers, the curves indicate their performance compared to that o similar size units now on the market. DI-T transformers are still smaller in size. Power rating and othe characteristics are identical to DO-T, but low frequency response (3 db down point) is 30% higher in frequency Units can be used for different impedances than those shown, keeping in mind that impedance ratio is constan Lower source impedance will improve response and level ratings . . . higher source will reduce them. Units ma be used reversed, input to secondary.

DO-T No.	MIL Type	Application	Pri. Imp.	D.C. Ma.‡ in Pri.	Sec. Imp.	Pri. Res.	Level Mw.	DI-T No.
DO-T1	TF4RX13YY	Interstage	20,000 30,000	.5 .5	800 1200	850	50	
DO-T2	TF4RX17YY	Output	500 600	3 3	50 60	60	100	DI-T2
DO-T3	TF4RX13YY	Output	1000 1200	3 3	50 60	115	100	DI-T3
DO-T4	TF4RX17YY	Output	600	3	3.2	60	100	
DO-T5	TF4RX13YY	Output	1200	2	3.2	115	100	
DO-T6	TF4RX13YY	Output	10,000	1	3.2	1000	100	
DO-T7	TF4RX16YY	Input	200,000	0	1000	8500	25	
DO-T8	TF4RX20YY	Reactor 3.5 Hys. @ 2 Ma. DC, 1 Hy @ 5 Ma. DC (DI-T8 is 2.5 Hy @ 2 Ma.)				630		DI-T8
DO-T9	TF4RX13YY	Output or driver	10,000 12,500	1 1	500 CT 600 CT	800	100	DI-T9
DO-T10	TF4RX13YY	Driver	10,000 12,500	1 1	1200 CT 1500 CT	800	100	DI-T
DO-T11	TF4RX13YY	Driver	10,000 12,000	1 1	2000 CT 2500 CT	800	100	DI-T
DO-T12	TF4RX17YY	Single or PP output	150 CT 200 CT	10 10	12 16	11	500	
DO-T13	TF4RX17YY	Single or PP output	300 CT 400 CT	7 7	12 16	20	500	
DO-T14	TF4RX17YY	Single or PP output	600 CT 800 CT	5 5	12 16	43	500	
DO-T15	TF4RX17YY	Single or PP output	800 CT 1070 CT	4 4	12 16	51	500	
DO-T16	TF4RX13YY	Single or PP output	1000 CT 1330 CT	3.5 3.5	12 16	71	500	
DO-T17	TF4RX13YY	Single or PP output	1500 CT 2000 CT	3 3	12 16	108	500	
DO-T18	TF4RX13YY	Single or PP output	7500 CT 10,000 CT	1 1	12 16	505	500	
DO-T19	TF4RX17YY	Output to line	300 CT	7	600	19	500	DI-T
DO-T20	TF4RX17YY	Output or matching to line	500 CT	5.5	600	31	500	DI-T
DO-T21	TF4RX17YY	Output to line	900 CT	4	600	53	500	
DO-T22	TF4RX13YY	Output to line	1500 CT	3	600	86	500	DI-T
DO-T23	TF4RX13YY	Interstage	20,000 CT 30,000 CT	.5 .5	800 CT 1200 CT	850	100	DI-T
DO-T24	TF4RX16YY	Input (usable for chopper service)	200,000 CT	0	1000 CT	8500	25	
DO-T25	TF4RX13YY	Interstage	10,000 CT 12,000 CT	1 1	1500 CT 1800 CT	800	100	
DO-T26	TF4RX20YY	Reactor 6 Hy. @ 2 Ma. DC, 1.5 Hy. @ 5 Ma. DC				2100		
DO-T27	TF4RX20YY	Reactor 1.25 Hy. @ 2 Ma. DC, .5 Hy. @ 11 Ma. DC				100		
DO-TSH	Drawn Hipermalloy shield and cover for DO-T's, provides 25 to 30 db shielding.							

‡DCMA shown is for single ended useage (under 5% distortion—100MW—1KC) . . . for push pull, DCMA can b any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC)

*DO-T units have been designed for transistor application only . . . not for vacuum tube service. Patents Pending

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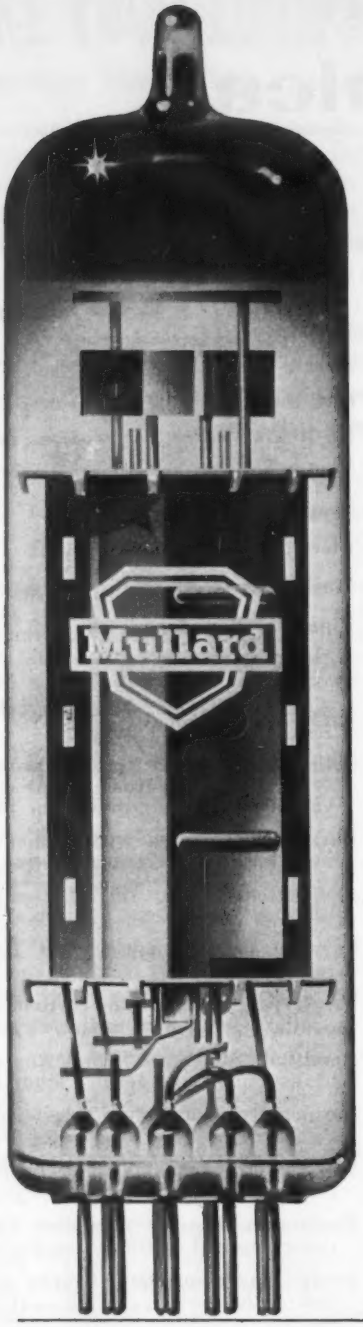

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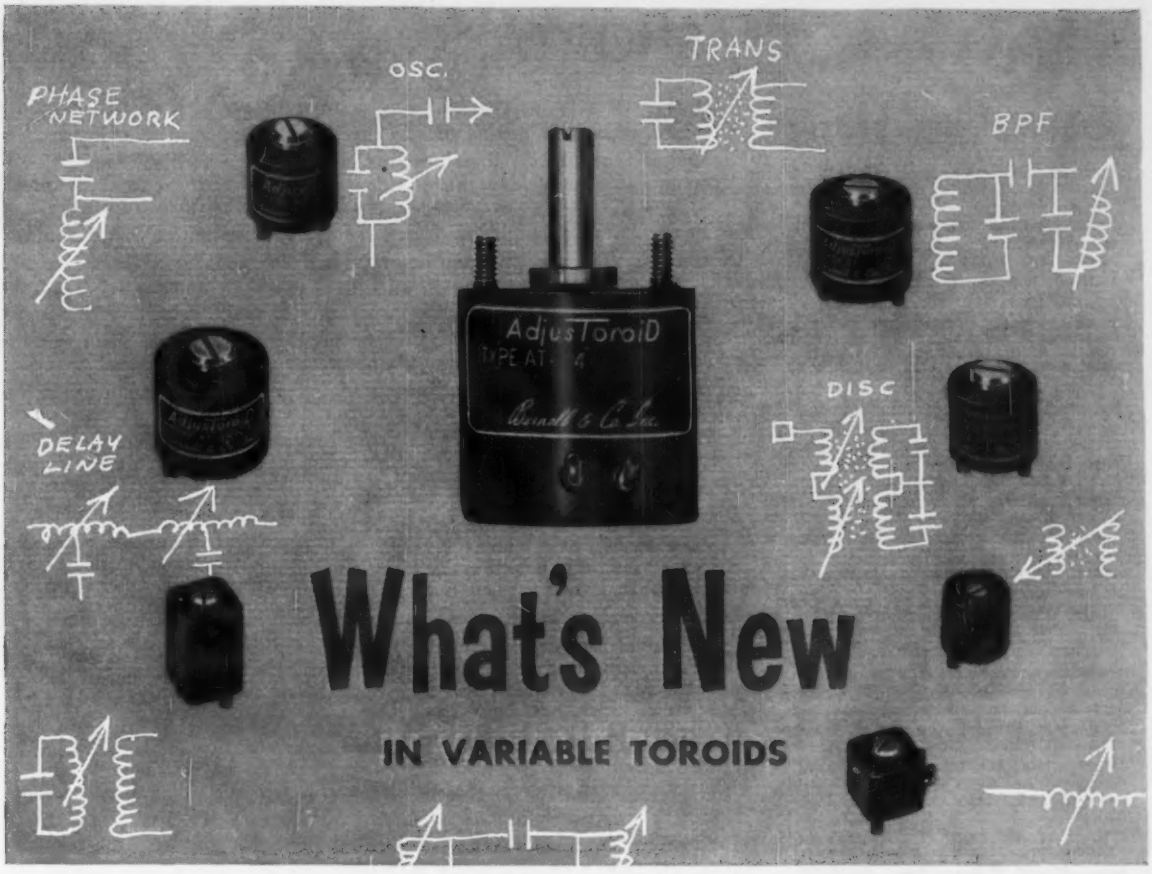

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	Length/ Dia.	Width	Hgt.	Wt.	Useful Freq. Range	Max Q	Max L in hys
AT-0	1 1/16		1"	2 oz	1 kc to 20 kc	10 kc	3 hys
AT-1	1 3/4	1 3/4	1 1/4"	7.25 oz	2 kc to 10 kc	4 kc	15 hys
AT-2	2 3/4	2 3/4	2 1/4"	24 oz	Below 2.5 kc	2.5 kc	125 hys
AT-4	1 15/64		1 1/4"	4 oz	1 kc to 16 kc	6 kc	15 hys
AT-6	1 1/16		1"	2 oz	10 kc to 100 kc	30 kc	.75 hys
AT-10	1 15/64		1 1/4"	4 oz	3 kc to 50 kc	20 kc	.75 hys
*AT-11	45/64	45/64	3/4"	.83 oz	2 kc to 25 kc	15 kc	5 hys
*AT-12	45/64	45/64	3/4"	.83 oz	15 kc to 150 kc	60 kc	.5 hys
AT-15	1 21/32		1 7/8"	14 oz	Below 5 kc	4 kc	125 hys
AF-51	1 15/64		2"	5 oz	30 cps to 500 cps	120 cps	1000 hys
AF-52	1 15/64		2"	5 oz	50 cps to 1 kc	250 cps	1000 hys
*AF-87	45/64	45/64	1 1/4"	1.7 oz	90 cps to 2 kc	400 cps	80 hys
*AF-88	45/64	45/64	1 1/4"	1.7 oz	.16 kc to 4 kc	800 cps	42 hys
†ATE-11	3/4		3/4"	.83 oz	2 kc to 25 kc	15 kc	5 hys
†ATE-12	3/4		3/4"	.83 oz	15 kc to 150 kc	60 kc	.5 hys

Variation—10%

Special "pot" type sub-miniature Adjustoroids are not available with AT-11, AT-12, AF-87, AF-88.

†Special screw mountings are available with the ATE-11 and ATE-12 in printed circuit applications for "plug in" types. Where vibration and shock are significant considerations, mounting screws serve as terminal connections.

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SHOPTALK . . .

JET-AGE NAVIGATION. Electronics is the principal means by which jet-age air traffic will be controlled. And an important part—technically, and to this industry, economically—of the control will be in short-range navigation aids.

International Civil Aviation Organization, which settled on VOR in 1949 as standard, is up to its eyes in a hot argument about whether to keep VOR and improve it, or junk it for another system.

The argument erupted in an open technical meeting of ICAO in Montreal earlier this month. Associate Editor Leary had the background ready, and Montreal correspondent Mike Gutwillig shot a story under the wire on the shape of the argument in time to make this issue. The story begins on p 30.

OFF-HOURS LIFESAVING. Forty engineers of the Illinois Bell Telephone Co. have found a way to spend their off hours, and it beats watching tv or even bowling.

They are working with doctors at the University of Chicago to develop new electronic equipment for medical diagnosis. Results so far: portable heartbeat analyzer, cytodiagnostic trainer, electronic calorimeter and an electronic stethoscope.

The group's name is an acronym: SAVE—Service Activities of Volunteer Engineers. There is so much electronics can do to save human life—and so much that remains to be done.

See Midwestern Editor Harris' story on p 38.

Coming In Our March 6 Issue . . .

METAL FORMING. Exotic alloys frequently can be worked only within narrow bands of tension and stress. According to G. J. Crowdes, chief engineer of Assembly Products, Inc., in Chesterland, O., electronic control helps form such metals with a high degree of precision.

Crowdes describes a control which receives signals from a strain gage and elongation detector and determines the yield point of the metal being formed. Control automatically adjusts tension to form metal without fracture.

NEUTRON FLIGHT. Measurements of velocities of neutrons and other atomic particles are of great significance in nuclear research. Techniques capable of time measurements in the order of millimicroseconds are required.

H. W. Lefevre and J. T. Russell of GE's Hanford Labs in Richland, Wash., have developed a high-resolution time-interval analyzer for multichannel time measurements. Resolution of the device, known as a vernier chronotron, is better than one millimicrosecond.

SPEEDERS BEWARE. Doppler radar is currently being applied by police in monitoring the speed of motor vehicles. J. R. Barker, research director of Automatic Signal Div., Eastern Industries, Inc., in Norwalk, Conn., describes a portable transmitter-receiver unit powered by a vehicular battery system or 110 v a-c. Provisions are made for differentiating between slow and fast-moving vehicles.

PROGRAMMED INSERTER. With the development of printed circuit assemblies, the use of automatic machinery is becoming more common in our industry for the insertion of components on printed circuit boards. Special problems still arise, however, in cases where there are only small production runs involved.

With these problems in mind, IBM's S. B. Korin and F. L. Spencer have developed an automatic assembly machine with great flexibility programmed by a modified tape reader.

NEW! HIGH-TEMPERATURE FABMIKA® CAPACITORS

. . . standard ratings for 260°C

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Sprague's new FABMIKA Capacitors can really handle the HOT ones! . . . jet ignition, missile controls, atomic reactors . . . any high voltage d-c power supply where high temperature, small size, and light weight are important . . . especially where components are immersed in a dielectric fluid.

● Sprague's new FABMIKA Capacitors rely on a specially processed dielectric for their heat resistant properties. Developed through three years of research and manufacturing, this dielectric consists of silicone-bonded mica paper which can function effectively in temperatures up to 260°C and, in special designs, up to 310°C. There's a choice of four standard temperature ranges: from −55°C to +125°C, +165°C, +200°C, and +260°C.

TYPICAL INSULATION RESISTANCE	
Temp. °C	MΩ X μF
125	300 (min.)
165	100 (min.)
250	50 (min.)
260	10 (min.)

Maximum Dissipation Factor: .15% at 400 cy. 25°C.

● Radiation resistance is another outstanding characteristic of FABMIKA Capacitors. They have been application tested in reactors under high dosage rates without harmful loss of capacitance.

● Another important application is 400 cycle a-c power supplies where their low dissipation factor results in small capacitors with minimum rise in temperature under operating conditions.

● Miniature, high-reliability pulse forming networks are still another well tested application.

● FABMIKA Capacitors are available in four constructions: uncased (up to 200°C), uncased and clamped (up to 260°C), cast epoxy housing (up to 200°C), and drawn metal case (up to 260°C standard and 310°C special).

● For complete specifications, write for Engineering Bulletins to the Technical Literature Section, Sprague Electric Co., 35 Marshall St., North Adams, Mass.

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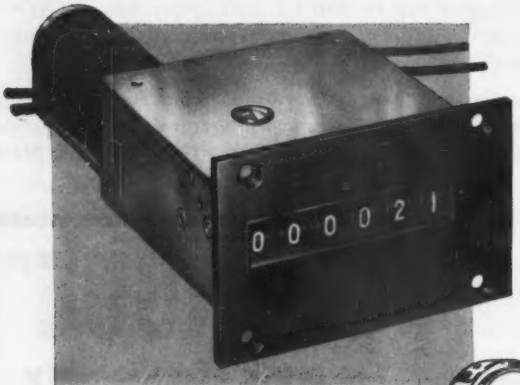
When customers come after you with claims concerning your product's performance, can you prove your position? You can, to everyone's satisfaction, if Veeder-Root Counters are built into your product as standard, integral parts. For then your customers have Facts-in-Figures on actual performance on the job, figures that settle arguments fairly and squarely . . . in fact, often prevent misunderstandings in the first place. What's more, when you build-in V-R Counters, you build up your product's sales appeal . . . as many manufacturers have found to their profit. So can you. Write and find out how.

You always "Know the score" when you count on Veeder-Root!



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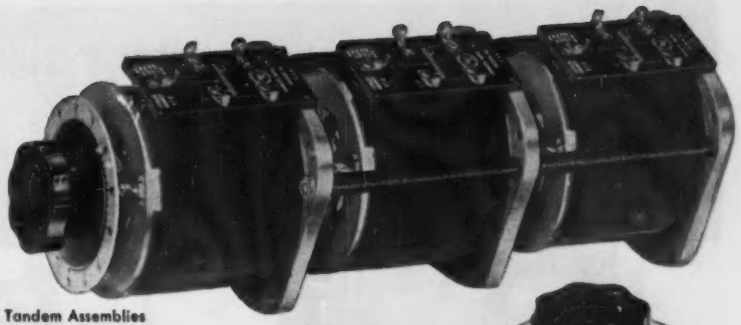
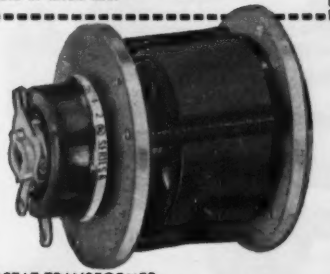
Enclosures for portable or fixed use.

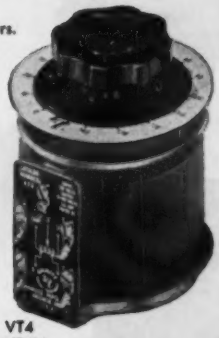


Tandem Assemblies in all three sizes of Ohmite Variable Transformers.



RHEOSTAT-TRANSFORMER TANDEM ASSEMBLIES. EXCLUSIVE WITH OHMITE

VT2
VT2N



VT4
VT4N

VT8
VT8N

OHMITE® "v.t." Variable Transformers Give a "Bonus" in Current Capacity

EXPANDED LINE—Ohmite now offers industry six basic models with current ratings sufficient to meet a large percentage of industrial applications. The new line includes enclosed units and tandem assemblies. Two models, VT2 and VT4, offer capacity greater than competitive units of comparable size and price. *An additional and sizeable "bonus" in current* is given in all sizes when the overvoltage feature is not required ("N" suffix, see below).

ADVANCED FEATURES—Positive current transfer achieved with direct brush to slip-ring, pig-tailed connection; table or panel mounting—on VT4 and VT8 sizes, adjustable shaft moves to brush or base side; interchangeable with other popular types both electrically and "mounting-wise"; durable rhodium plating on brush track for longer life.

SPECIALS ENGINEERED FOR YOUR NEEDS—Transformers can be modified to meet different requirements such as special shafts for nonstandard panel thicknesses, auxiliary switches, taps on transformer winding for fixed intermediate voltages, and motor drives for remote control or servo-operation. The only manufacturer in the industry concurrently producing power rheostats, tap switches, and variable transformers, OHMITE can also offer in-tandem combinations of these items.

BASIC MODELS (with overvoltage) All inputs 120 v ac*

MODEL VT2	MODEL VT4	MODEL VT8
Volts output: 0-120/132	Volts output: 0-120/140	Volts output: 0-120/140
Amps output: 1.5	Amps output: 3.5	Amps output: 7.5

BASIC MODELS (without overvoltage) All inputs 120 v ac*

MODEL VT2N	MODEL VT4N	MODEL VT8N
Volts output: 0-120	Volts output: 0-120	Volts output: 0-120
Amps output: 1.8	Amps output: 4.75	Amps output: 10.0

**Units available for 240-volt input also*

Write for Bulletin 151

Available from Ohmite Distributors or direct from factory

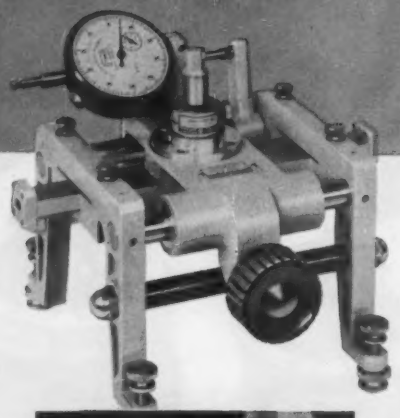
OHMITE® QUALITY Components

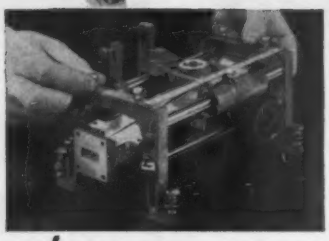
OHMITE MANUFACTURING COMPANY | 3610 Howard Street Skokie, Illinois

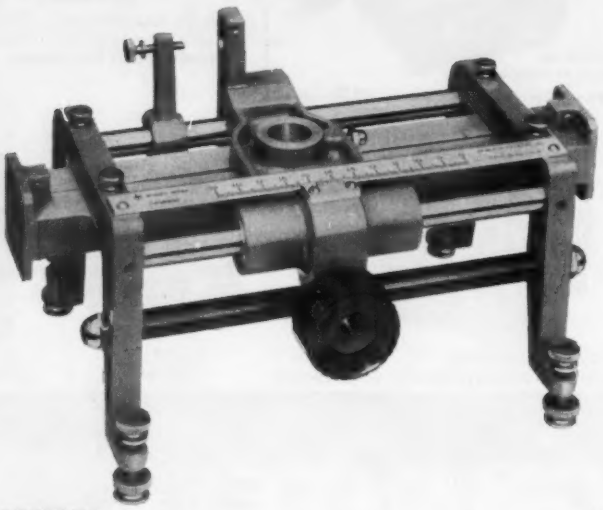
RHEOSTATS RESISTORS RELAYS TAP SWITCHES R.F. CHOKES
VARIABLE TRANSFORMERS TANTALUM CAPACITORS DIODES

Measure impedance and other system characteristics,

500 MC to 40 KMC







809B and 814B
UNIVERSAL PROBE CARRIAGES

- **Coverage 3 to 40 KMC**
- **Sections interchange in 30 seconds**
- **Dial gauge accuracy, highest stability**

Models 809B and 814B are rugged, precision Universal Probe Carriages designed for use, respectively, with ⓗ 810B and 815B waveguide slotted sections. The 809B/810B combination covers frequencies 3.95 to 18.0 KMC, and the 814B/815B combination covers frequencies 18.0 to 40.0 KMC. For waveguide measurements involving several bands, the cost of a special probe and carriage assembly for each band is eliminated and much engineering time is saved since waveguide sections can be changed in 30 seconds. Model 809B has a vernier scale reading to 0.1 mm and can be fitted with a dial gauge for greater accuracy. Model 814B is equipped with a dial indicator reading to 0.01 mm.

Specifications

ⓗ 809B Universal Probe Carriage

Carriage:	Mounts ⓗ 810B Slotted Sections and ⓗ 806B Coaxial Slotted Section (not shown: 3 to 12 KMC, 50 ohms impedance, Type N connectors).
Probe Required:	ⓗ 442B Broadband Probe plus ⓗ 440A Detector or ⓗ 444A Untuned Probe.
Probe Travel:	10 centimeters.
Accuracy:	With waveguide sections, 1.02 SWR easily read. Slope error eliminated by adjustment.
Price:	$160.00.

ⓗ 814B Universal Probe Carriage

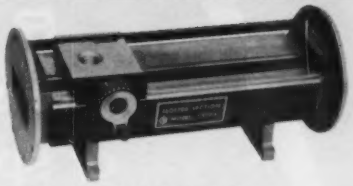
Carriage:	Mounts ⓗ 815B Slotted Sections.
Probe Required:	ⓗ 446B Untuned Probe.
Accuracy:	SWR of 1.02 easily read.
Price:	$200.00.

WORLD'S MOST COMPLETE LINE OF PRECISION,

quickly, accurately, with these low cost, precision instruments!

810B Waveguide Slotted Sections— 3.95 to 18.0 KMC.

These accurately machined sections of waveguide have a small, tapered, longitudinal slot, and fit the 809B Universal Probe Carriage in a precisely indexed position. A traveling probe mounted on the carriage samples the electric field along the slot, and permits precise plotting of variations. Slot reflection is less than 1.01 SWR. For prices, list of 810B waveguides available, see Table 1 below.



S810A Waveguide Slotted Section— 2.6 to 3.95 KMC.

This instrument is a conventional slotted waveguide complete with a probe carriage mounted directly on the section. It is available in the S-band only and will operate with 442B or 444A probes. SWR less than 1.01. $450.00.

815B Waveguide Slotted Sections— 18.0 to 40.0 KMC.

Available in K and R band sizes, these waveguide slotted sections are similar to 810B sections and, like 810B units, are accurately machined from precision castings to insure a uniform cross-section. Prices and details below.

Table 1—810B/815B Slotted Sections.

Model	Frequency Range KMC	Fits Waveguide Size (in.)	Overall Length (in.)	Price
G810B	3.95 - 5.85	2 x 1	10¼	$110.00
J810B	5.20 - 8.20	1½ x ¾	10¼	110.00
H810B	7.05 - 10.0	1¼ x ⅝	10¼	110.00
X810B	8.20 - 12.4	1 x ½	10¼	90.00
P810B	12.4 - 18.0	.702 x .391	10¼	110.00
K815B	18.0 - 26.5	.500 x .250	4½	265.00
R815B	26.5 - 40.0	.360 x .220	4½	265.00

805A/805B Coaxial Slotted Lines— 500 MC to 4 KMC.

For SWR, wavelength, impedance and system flatness measurements in coaxial systems. Exclusive parallel-plane design for higher accuracy, stability. Negligible slope, SWR less than 1.04, reads in cm and mm to 0.1 mm. 805A, for 50 ohm lines, Type N connectors, $450.00. 805B, for 46.3 ohm lines, UG-45/U male and UG-46/U female connectors, $450.00.

HEWLETT-PACKARD COMPANY

5427A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A. • CABLE "HEWPACK" • DAVENPORT 5-4451

FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

HIGH VALUE MICROWAVE MEASURING EQUIPMENT

...for a wide range of computer applications!

Now—commercially available from RCA—a comprehensive line of fast-switching, low- and high-drive, memory cores and several new memory-plane designs to provide equipment designers with one of the broadest lines of memory core products in the industry.

MEMORY CORES • In addition to a line of standard ferrite cores developed for coincident-current memory applications (ranging in switching time from 0.2 μ sec. to 3 μ sec.), RCA now offers a new group of ferrite cores particularly suited for both high-speed, word-address memories, and slow-speed, low-drive coincident-current memories. These cores are available for an applied field (H) ranging from 0.2 to 1 oersted, and in sizes from 0.050" x 0.030" to 0.370" x 0.290". The smaller-size cores make possible the design of high-speed memory devices with driving currents suitable for either transistor or tube drivers. Typical characteristics are given in the table.

MEMORY FRAMES • A compact, rugged aluminum frame utilizing a new stack-wiring concept makes possible a "bit-packing factor" greater than ever before. 8,192 bits may be stored in a 7" x 7" x 0.3" frame. For more economical designs and even greater compactness, a laminated frame accommodating 8,192 bits in a 5½" x 5½" x ¼" space (including terminals) is also available.

FERRITE APERTURE PLATES • RCA's apertured-plate construction utilizing ferrite-core material having low-drive, medium-speed characteristics, can store 256 bits of information in a space less than 0.9" x 0.9" x 0.025", thus making possible the design of compact memories for transportable equipment in which minimum weight and space are vital considerations.

The aperture memory plates have a nominal full driving current requirement of 320 ma., a switching time of about 1.8 μ sec., and an undisturbed output (1) signal (uV_1) of greater than 40 mv. making them especially suitable for use in transistorized circuits. In addition, the precision registration of the holes makes it possible to stack the aperture plates quickly and accurately.

Rigid production controls insure excellent uniformity of undisturbed output signal and peaking time...testing assures dependable performance of each storage element.

Typical Characteristics of Ferrite Cores for 2:1 Coincident-Current Applications

RCA Type▲	T_1 μ sec.	T_0 μ sec.	uV_1 mv.	dV_2 mv.	Driving Current ma. (I_m/I_{max})	T_r μ sec.
XF-3806	.27	.13	160	26	1100/660	.12
XF-4019	.67	.32	106	14	725/450	.12
XF-3018H	1.18	.53	55	9	460/275	.20
XF-4028	1.08	.60	72	4	380/190	.50
XF-3973	1.28	.71	48	5	350/215	.40
XF-3673	2.80	1.35	22	4	210/126	.50
XF-4003	2.60	1.45	24	3	190/95	.50
XF-4004	2.36	1.26	26	5	190/95	.50
XF-4005	4.10	2.35	10	5	125/63	.50
XF-4006	9.0	4.8	4.5	4.5	90/45	.50
XF-4007	7.5	4.3	4.5	5.0	70/35	.50
XF-4008	13.0	6.5	2.0	3.5	40/20	.50

Time is measured from 10% of current rise to 10% of voltage (uV_1) fall.
▲All type numbers are for .050" x .030" x .015" size.

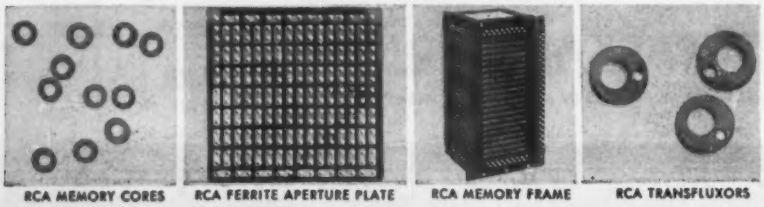
Typical Characteristics of Ferrite Cores for Switching Applications
Switching Time (T_s) μ sec. vs. Applied Field (H) in oersteds

RCA Type▲	Switching Time (T_s)—μ sec. H =.3	H =1.0	H =1.5	H =2.0	H =3	H =4	H =5
XF-3806						.22	.18
XF-4019					.41	.24	.163
XF-3018H			1.12	.75	.36	.226	.161
XF-3973			.73	.42	.22	.138	.105
XF-3673		1.16	.83	.40	.22	.15	
XF-4003		1.04	.60	.39			
XF-4004	3.84	.90	.52	.34	.194	.129	
XF-4005	3.88	.81	.48	.312	.174		
XF-4006	2.36	.71	.41	.280	.142		
XF-4007	1.38	.48	.28	.194			
XF-4008	1.53	.41	.242	.165			

Time is measured from 10% rise to 10% fall of uV_1. Rise time of current pulse is approximately 35 millimicro-seconds. To convert drive in oersteds to current in amperes: For core size of .050 OD x .030 ID, multiply H x 0.25. For core size of .080 OD x .050 ID, multiply H x 0.41.
▲All type numbers are for .050" x .030" x .015" size.

For ferrite cores having uniformity to meet your most exacting design requirements, and for dependable delivery schedules, contact your local RCA Sales Representative.

RADIO CORPORATION OF AMERICA
Semiconductor and Materials Division
Special Ferrites ***Somerville, New Jersey***



RCA MEMORY CORES | RCA FERRITE APERTURE PLATE | RCA MEMORY FRAME | RCA TRANSFLUXORS

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East Central: 714 New Center Bldg., Detroit 2, Mich. TRinity 5-5600
Central: Suite 1154, Merchandise Mart Plaza, Chicago, Ill., WHitehall 4-2900
West: 6355 E. Washington Blvd., Los Angeles, Calif., RAymond 3-8361
Gov't: 224 N. Wilkinson Street, Dayton, Ohio BAldwin 6-2366
1625 "K" Street, N.W., Washington, D.C. District 7-1260
Route 202, Somerville, N. J. RAndolph 5-4500

ELECTRONICS NEWSLETTER

VANGUARD II meteorological satellite launched last week carries two Perkin-Elmer infrared detection units. One photocell, depending upon the spin of the satellite, constantly sweeps the sunlit side of the earth—as long as the satellite remains within 1,700 mi of the earth; apogee is actually 2,059 mi. Purpose is to pick up sunlight intensities reflected from cloud, land and sea areas in the form of ir, a key indication of weather patterns. Tiny ir detector converts photocell measurements into signals for the data storage system developed by the Army Signal Research and Development Lab. This unit handles 75 ft of ¼-in. tape, records data at a rate of 0.3 in. per/sec, and plays it back to earth at 15 in. per/sec via the Minitrack system.

RESEARCH indicates that maser operation is feasible at zero magnetic field using iron in aluminum oxide. Initial experiments at the University of Michigan were made with a pump frequency of 31 kmc and a signal of 12 kmc. Manganese formate also shows promise as material for zero-field maser with X-band pumping and S-band amplification.

Some 2,000 engineers and scientists testified to the impact of solid-state physics on our industry by attending the recent exhibitionless Solid-State Circuits Conference in Philadelphia. Microwave amplifiers, high-current switching devices and computer elements were highlighted.

HIGH-VOLTAGE TRANSISTORIZED IGNITION, already ordered by Detroit Arsenal (ELECTRONICS, p 11, Feb 6), is disclosed by The Electric Auto-Lite Co., the developer, to be compatible with conventional automotive electrical components. The Toledo firm says new single package system is slightly larger than the conventional ignition coil. New transformer and circuits are the key to the system, which is said to provide top voltage at all speeds and to eliminate starting failures due to "blued" contact points. Auto-Lite says system will have immediate use on military vehicles, industrial and marine engines, farm equipment and commercial fleets. It will probably be optional car equipment by 1961.

THERMOELECTRIC ACTION in metal depends upon the mass of impurity atoms in the metal, it is indicated by experiments just reported by Michigan State University. Physicists suggest that their laboratory technique for studying the mechanisms of thermoelectricity could be reversed for practical industry use. They say the amount and nature of impurities in unknown metals could be obtained by measuring their thermoelectric properties.

TINY 1,000-MI RANGE tv system may make possible ground observation of missile stage separation or spacecraft passengers. Such applications were suggested by Lockheed Missiles and Space division in announcement of its nine-pound battery-operated system. Transistorized unit weighing 42 oz supplies sweep and synchronizing signals to 42 oz camera; 14 oz unit contains camera controls; 50-watt f-m transmitter weighs 47 oz. Picture resolution capability is 500 lines, says firm.

USAF'S FIRST FLYING missile platform, the eight-jet B-52G, last week took another step toward operational readiness. The first one was delivered to SAC at Travis AFB, Calif. Hound Dog, the long-range, inertially guided supersonic missile to be carried by the B-52G, will be ready next year.

New airline requirements for instruments and systems for jet operations are being circulated by the International Air Transport Association. Altimeter static errors, takeoff monitors, attitude devices and recorders are covered.

AUTOMATIC TOOL-CHANGING, tape-controlled combination machine for small-lot manufacturers has been developed by Kearney & Trecker Corp., with GE supplying the electronic program controls. The machine, called the KTNC Milwaukee-Matic, can call on 961 different tools for milling, drilling, reaming, tapping and boring operations. Estimated cost of the machine with control system: $120,000. Both firms say the new machine bridges the gap between job shop mechanization and automation, claim it will pay for itself in one to three years for any manufacturer producing goods in small or medium lots.

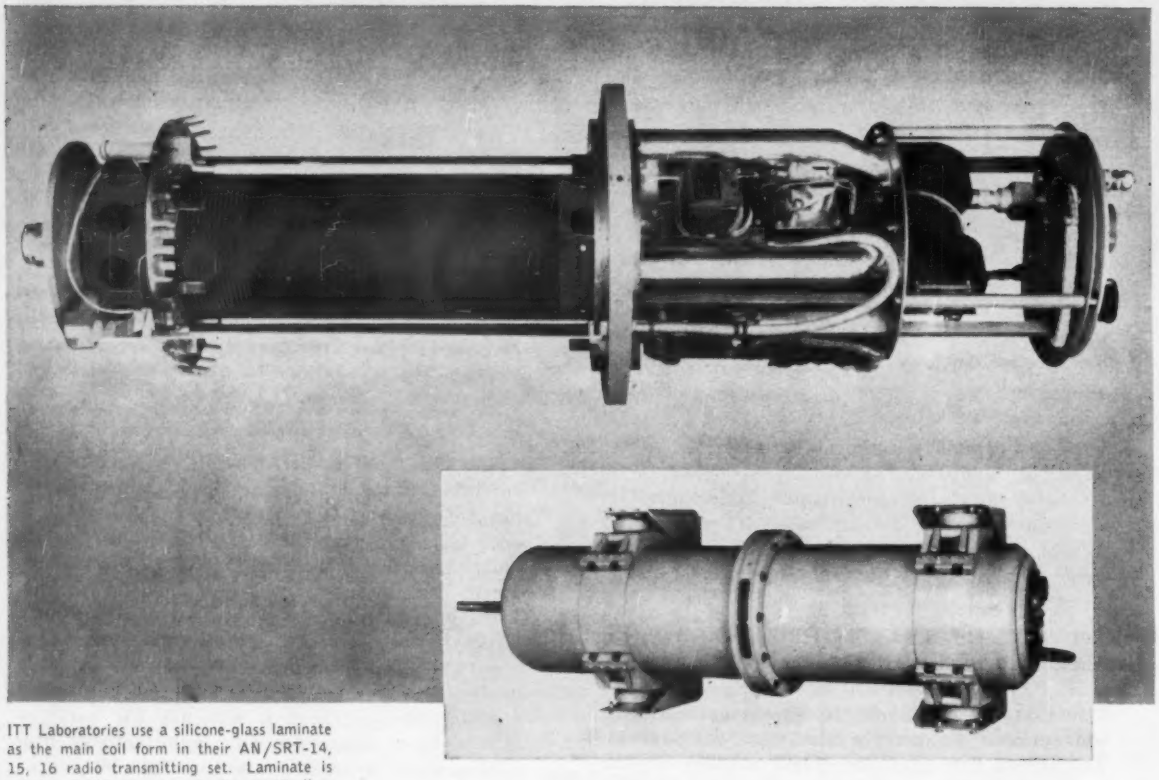
Two driverless tractor trailers will go into operation in April for the British Railways guided by an EMI Electronics control system called ERIC (Electronic Remote and Independent Control). Tractor follows wire laid along desired route.

THREE-DAY EXHIBITIONS this month in Frankfurt and Paris involving 32 top management and engineering personnel from 26 Bendix Aviation divisions cost an estimated $250,000. The firm reports nearly 300 requests for new licensing agreements. Bendix, with 42 licensees and 32 sales reps in Europe, felt a new sales approach was needed as new common market trade patterns develop. Major effort may come through newly formed Societe Anonyme D.B.A., which combines one French subsidiary and two French affiliates, with majority interest held by Bendix.

Design better products with

SILICONE-GLASS LAMINATES

. . . low loss factor, high moisture resistance



ITT Laboratories use a silicone-glass laminate as the main coil form in their AN/SRT-14, 15, 16 radio transmitting set. Laminate is tubular, 5.62" dia., wound with .064" silver wire. Primary reason for specifying silicone-glass: low loss factor at high frequencies.

TYPICAL PROPERTIES
OF SILICONE GLASS-LAMINATES*

Flexural Strength, psi	
at 25C	24,000
at 260C after 100 hr at 260C	4,600
Water Absorption, percent	0.05
Electrical Strength, volts/mil	
initial	310
after 200 hr at 260C	327
after 5000 hr at 260C	180
Dielectric Constant at 10^4 cycles	
Condition A[1]	3.67
Condition D[2]	3.68
Dissipation Factor at 10^4 cycles	
Condition A[1]	.002
Condition D[2]	.004

* As measured on samples 1/8 inch thick.
[1] As received.
[2] After 24 hr immersion in water at 23C.

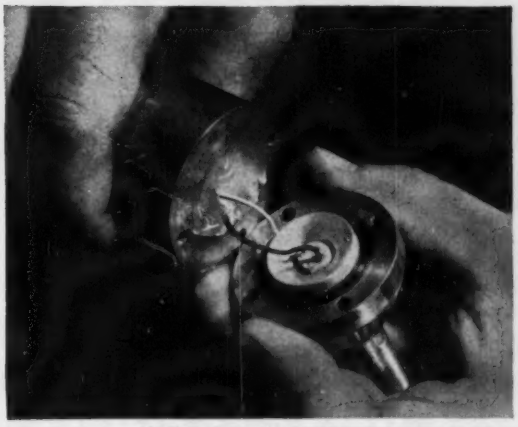
Laminates made with glass or asbestos cloth and Dow Corning silicone resins make excellent dielectric materials. These strong, lightweight laminates maintain their properties at continuous operating temperatures of 250 C . . . for short periods will withstand greater heat. Silicone-glass laminates have good mechanical strength in addition to low loss factor, low water absorption, superior resistance to arcing, corona, corrosive atmospheres and contaminants. They can be laminated in very thin sections; have fine machinability. Supplied as tubes, sheets, punched or molded shapes by leading laminators. Write for free booklet.

VISIT BOOTHS 4308-4310 AT THE IRE SHOW

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

Dow Corning Silicone Dielectrics

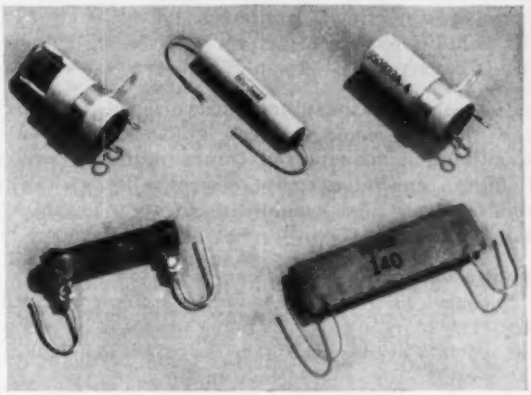


Southwestern Industrial Electronic's S-16 Geophone.

SILICONE COMPOUNDS SEAL OUT MOISTURE

Highly effective as dielectrics, Dow Corning compounds are easy to apply. They provide protection against arcs, grounds, shorts . . . improve surface resistivity. These silicone compounds retain their properties from —75 to 200 C. Employed as filling, potting, or coating materials for various types of electronic gear, they seal out moisture, increase reliability, retain their initial grease-like consistency.

CIRCLE 104 READERS SERVICE CARD



Resistors by Tru-Ohm Division of Model Engineering and Manufacturing Co.

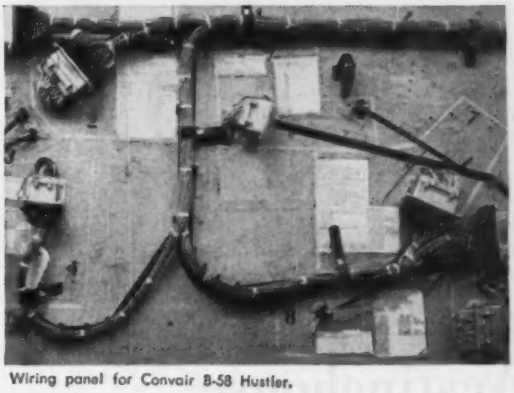
SILICONE VARNISH MAKES IMPROVED RESISTOR CEMENT

Heat-stable and exceptionally moisture-resistant, Dow Corning varnishes make very good bonding cements. In addition, they can take fairly high loadings of inorganic fillers without loss of properties. An appropriately filled Dow Corning varnish is often far superior to conventional materials for sealing wire wound resistors and other electronic devices. Set-up time is good.

CIRCLE 105 READERS SERVICE CARD

WIRE COVERING OF SILASTIC INSULATES FROM —90 to 250 C

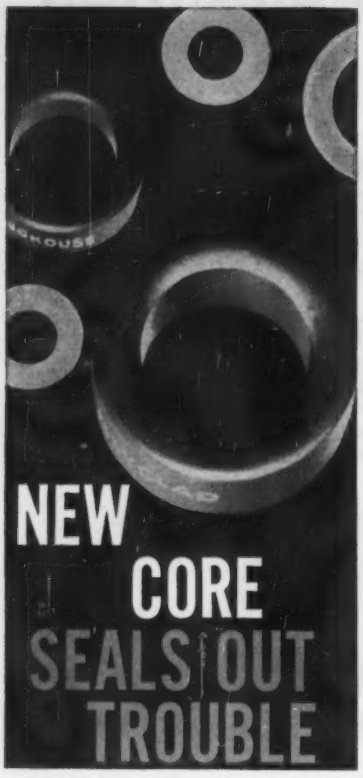
Here is a resilient dielectric that keeps its properties from —90 to 250 C. Silastic®, the Dow Corning silicone rubber, forms a durable, moisture resistant coating for wire, cable, and other electronic and electrical components. It resists arcing, corona, ozone, weathering, corrosive atmospheres, and many fuels and solvents. Meets MIL-W-8777 specifications. Available from leading wire manufacturers.



Wiring panel for Convair B-58 Hustler.

For further information on these products write Dept. 488

CIRCLE 106 READERS SERVICE CARD



The Westinghouse hermetically sealed, Polyclad Hipermag core is the newest development in cores for magnetic amplifier applications. Applied over a new specially designed aluminum box housing the core, Polyclad insulation hermetically seals the core and allows encapsulating, casting or impregnating without altering magnetic properties. This special core:

- Stops magnetic amplifier rejects caused by changed magnetic values.
- Is suitable for all environmental conditions — high temperatures, humidity and high-voltage stress.
- Eliminates costly core taping.
- Is tested by Roberts constant-current, flux reset technique, or to your specification.

Available in production lots with normal delivery, these cores are supplied in special sizes or in standard AIEE sizes.
For more information about these or other Hipermag or Hipersil® cores, call your Westinghouse representative . . . or write Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pennsylvania. J-70855

YOU CAN BE SURE...IF IT'S
Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

CIRCLE 11 READERS SERVICE CARD

WASHINGTON OUTLOOK

IN ITS PRIME CONTRACT AWARD to ITT and RCA for design and development of the 480L communications support system—to update and broaden Air Force worldwide communications—the Air Force has clamped unprecedented restrictions on the contractors.

The restrictions are the Pentagon's response to criticism of the weapon system management concept.

The Air Force has placed certain limitations on other system contractors in the past. But the 480L restrictions on ITT and RCA are more comprehensive and specific, and are a tip-off of restrictions to be placed on future weapon or electronic system prime contractors.

The contractors are prevented from designing or engineering the communications system so as to "accrue an advantage in subsequent procurement" over other electronics firms. They are directed to compete "where feasible" with other companies for production of components.

As to new business the 480L project may generate, the two firms are limited to a level that is "reasonably related" to the volume of Air Force contracts the companies have had in "prior years."

The 480L project is starting out on a small scale. Only $3 million has been allocated to ITT (senior contractor), to RCA (associate contractor), and to Hughes Aircraft and Hoffman Electronics (subcontractors).

The project is geared to expand and modernize the Air Force's present $491-million worldwide communications system. Pentagon strategists consider the system inadequate for future military requirements—in terms of reliability, capacity, security, compatibility with other military and commercial systems, and capabilities in data, graphics, and voice transmissions.

- **A reorganization of the Navy Dept.** is in the works. It's likely to change the service's system of buying electronic and other defense hardware. The reorganization is being proposed by a top-level committee of officials headed by Under Secy. William B. Franke, who's slated to become Secy. of the Navy in June.

  Detailed recommendations were originally due Jan. 1. Pentagon insiders expect the report to propose a major overhaul of the Navy's traditional system of bureau organization. The bureaus—Aeronautics, Ordnance, Yards and Docks, Ships, and others—now have more autonomy than subordinate agencies in the two other services.

  Each bureau is an important electronics buyer. In addition, the Office of Naval Research, which under the present system rates lower in the Navy's hierarchy, also supports a considerable volume of electronic research.

  The reorganization is expected to elevate the Navy's research organization and to centralize electronic procurement responsibilities—putting the Navy's administrative operations into a more updated and streamlined appearance.

- **Army officials are seething** over the Defense Dept.'s recent cancellation of Sylvania Electric's Plato antimissile system. The project was recently taken out of the Army's hands and placed under control of the Advanced Research Projects Agency. ARPA failed to include funds for the project in its latest budget.

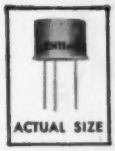
  The project, using the Nike-Zeus missile, was to be a field defense against tactical ballistic missiles. The Army praises Sylvania's "very substantial contribution to the state-of-the-art" in ballistic missile defense—notably in the field of acquisition radar.

CIRCLE 12 READERS SERVICE CARD→

NEW TI HIGH FREQUENCY DIFFUSED-BASE GERMANIUM TRANSISTORS

For maximum mechanical strength and heat dissipation, TI diffused-base "mesa" construction mounts wafer directly to header. Extremely close product uniformity also results from this newest gaseous-diffusion manufacturing technique.

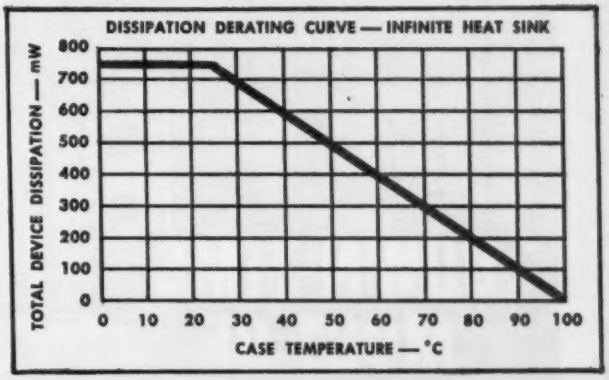
750 MC • 750 mW



Guaranteed current gains of 12, 10 and 8 db minimum at 100 mc with new TI 2N1141, 2N1142 and 2N1143 diffused-base germanium transistors! Alpha cutoff ratings up to 750 mc coupled with 750 mW power dissipation at 25°C case temperature make these newest TI transistors ideal for military high frequency power oscillators and amplifiers where assured reliability and performance are of primary importance.

All units are 100% production stabilized at temperatures well above their 100°C rated junction operating point . . . exceed MIL-T-19500A specifications . . . and are *in stock now.*

Contact your nearest TI sales office or nearby TI distributor *today* . . . for immediate delivery.



absolute maximum ratings @ 25°C case temperature

	2N1141	2N1142	2N1143	
Collector Voltage Referred to Base	−35	−30	−25	V
Emitter Voltage Referred to Base	−1	−0.7	−0.5	V
Collector Current	−100	−100	−100	mA
Emitter Current	100	100	100	mA
Device Dissipation (infinite heat sink)	750	750	750	mW
Collector Junction Temperature	+100	+100	+100	°C
Storage Temperature Range		−65 to +100		°C
Thermal Resistance Junction to Mounting Base	0.1	0.1	0.1	°C/mW

typical characteristics @ 25°C case temperature

Frequency Cutoff (Common Base)	750	600	480	MC
Collector Reverse Current, $V_{cb} = -15V$, $I_e = 0$	1	1	1	μA
Saturation Voltage, $I_b = -70mA$, $I_c = 175mA$	2	2	2	V
Small Signal Short Circuit Forward Current Transfer Ratio, $V_{cb} = -10V$, $I_e = -10mA$, $f = 1000$	0.95	0.97	0.97	

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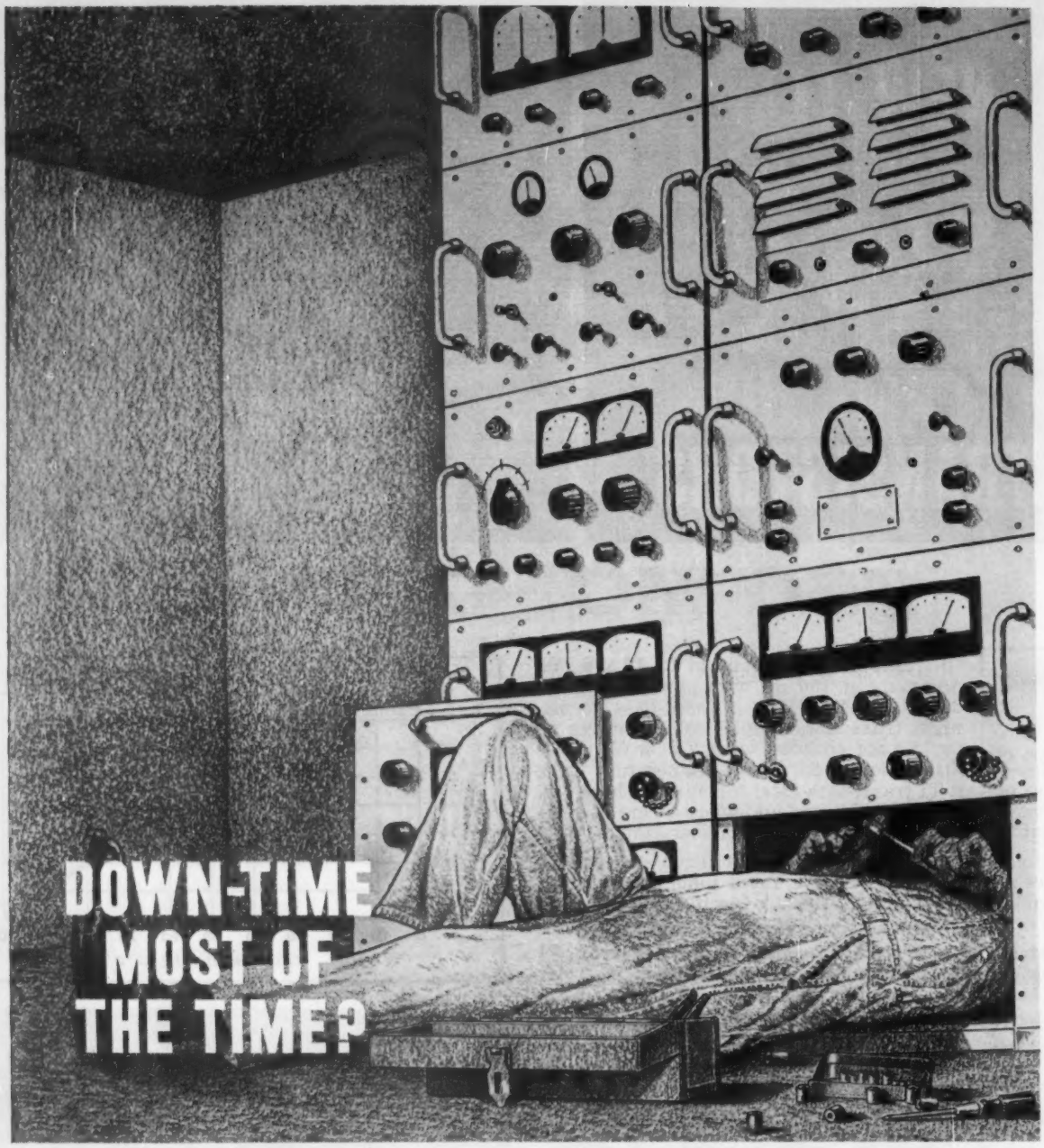

Grant Slides have been the pattern for **all** slide designs. While Grant is flattered, it is important to point out to designers and engineers that Grant research, design and sales engineering have been and are the factors that place the nation's leading industrial manufacturers on our list of customers.
If you require imaginative assistance in determining the proper slide for your equipment — or, if you'd simply like to discuss the possibilities for slides in your units, Grant sales engineers are at your service — as they have been ever since the first industrial slide (a Grant slide!) was marketed.

The nation's first and leading manufacturer of slides

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CIRCLE 13 READERS SERVICE CARD

CIRCLE 14 READERS SERVICE CARD→

Electron Tube News
—from SYLVANIA

Announcing the Sylvania

SARONG CATHODE

A NEW ERA IMPROVEMENT IN THE HEART OF THE ELECTRON TUBE

The Sylvania Sarong Cathode—*A New Era*

Sylvania Sarong Cathodes pave the way to new performance standards for present and future tube types

Out of the advanced research laboratories of Sylvania's Electron Tube Division comes a revolutionary innovation in cathode coating, Sylvania Sarong. Sylvania scientists and engineers have succeeded in transforming conventional cathode coating into a thin uniform film that is precision-wrapped and securely bonded around each cathode sleeve.

Now in use in nearly one million Sylvania tubes, it is already contributing to a new efficiency in electron tube performance. It promises to open the way to new tube designs that will outperform many of today's advanced devices. First tubes to incorporate the Sarong Cathode are a number of Sylvania Tuner Types.

New Cathode Uniformity

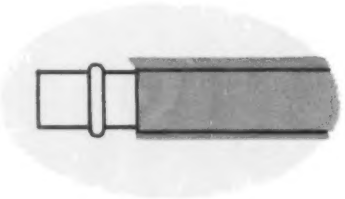
Sylvania Sarong insures that every cathode will be coated uniformly and precisely because its thickness, texture, length and weight are pre-controlled before application. The thickness of Sylvania Sarong coating is held to tolerances five times closer than conventional sprayed coatings. This new superiority in coating uniformity has already contributed to a reduction in cathode-grid shorts and intermittent short circuits.

Reduced Noise

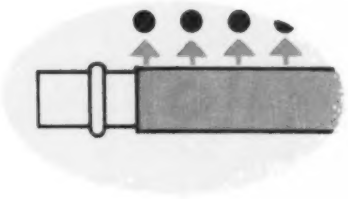
The uniformity of Sylvania Sarong coating makes it possible to obtain an over-all uniformity in spacing between cathode and grid never before achieved in mass produced electron tubes.

Preliminary tests indicate that this results in an improved noise figure of up to 0.6 db for TV. It also contributes to more uniform and higher levels of

Here are some of the ways Sarong

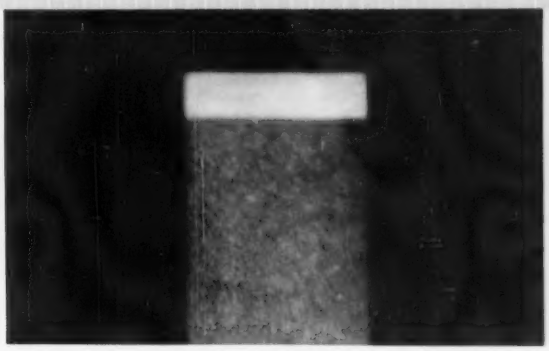


1. Uniform coating thickness of Sylvania Sarong Cathode means more uniform plate current, higher and more uniform levels of Gm and reduced noise



2. Sharp even edge and greater uniformity of Sarong coating virtually eliminates the possibility of end-leakage and contributes to better cut-off

improvement in the heart of the electron tube



Photomicrograph comparison of a conventional cathode, left, and Sylvania's Sarong Cathode in operation shows its superior coating uniformity contributing to better emission and more uniform heat distribution

Gm and also to a more uniform plate current.

Because Sarong coating can be held to much closer tolerances, new tube designs incorporating more closely spaced elements become possible . . . opening the way to standards of tube performance never before achieved.

More Uniform Emission

The even distribution and smooth texture of Sylvania Sarong assures a new uniformity in cathode emission. The possibility of hot spots is virtually eliminated. Preliminary tests have already shown that Sarong Cathodes have pulse emission characteristics some 10% greater than conventional cathodes. Interface impedance due to poor coating adherence has also been improved, promoting better electron flow.

Better Cut-Off

Because Sylvania Sarong results in a more uniform surface and a more clearly defined coating, sharper cut-off characteristics and better control are achieved. The Sarong coating also eliminates the possibility of coating particles adhering inside the cathode sleeve.

Improved Temperature Distribution

All of the physical properties of Sylvania Sarong coating contribute to a new uniformity in cathode temperature. This contributes to noise reduction and better over-all performance throughout life. It enables the tube to tolerate a wider range of operating conditions, such as varying heater voltages, without great changes in emission.

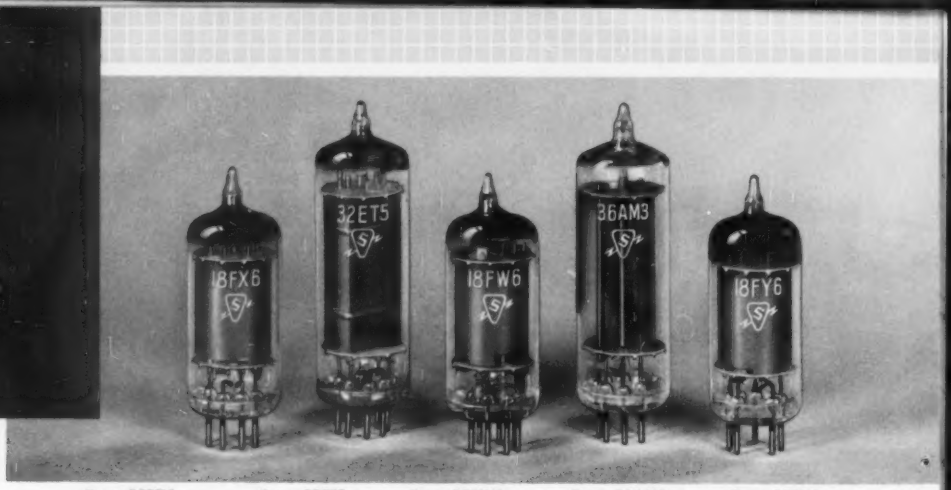
Cathodes contribute to better tube performance

3. Better diameter control with Sarong coating makes a closer spaced tube structure possible with higher Gm, more gain

4. More uniform heat distribution is possible with Sylvania Sarong Cathodes. Hot spots are virtually eliminated and the life and over-all performance of the tube is improved

5. Sylvania Sarong Cathode coating makes possible a new uniformity of cathode emission from tube to tube

Other *New* Sylvania Developments



Type 18FX6— Dual control miniature semi-remote cut-off pentode

Type 32ET5— Miniature beam power pentode

Type 18FW6— Miniature semi-remote cut-off pentode

Type 36AM3— Miniature half-wave rectifier

Type 18FY6— Miniature high mu triode double diode

New 100 ma All American Five

Radio set designers can now secure all of the performance advantages of the famous All American Five design with lower heater power and reduced heat dissipation. This opens the way to substantial economies in set components without a sacrifice of over-all set quality.

The Sylvania 100 ma All American Five includes the following types: 18FX6, 18FW6, 18FY6, 32ET5 and 36AM3. The function of each type corresponds directly in order to the standard All American Five types 12BA6, 12BE6, 12AV6, 50C5 and 35W4.

The new 100 ma All American Five tube complement is already being designed into the sets of one major radio manufacturer. Contact your Sylvania representative now for full information on the new types or write Sylvania directly.

New Spiral Accelerator C-R-T

Now ready for production at Sylvania's Industrial and Military C-R-T Department is one of the new high-quality cathode-ray tubes—the Spiral Accelerator. Designed for high-quality scope applications the advanced tube sets a new standard for high linearity and superior resolution. This is achieved through the spiral design that gives a smoother voltage gradient from deflection plates to screen.

Sylvania stands ready to produce Spiral Accelerator types to fit your specific needs. Contact your Sylvania representative or write Sylvania directly. We will welcome the opportunity to discuss your special cathode-ray tube requirements with you.

New Sylvania Spiral Accelerator C-R-T

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
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It takes a TEAM
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The control of time is an extremely complex science that demands a thorough knowledge of many individual technologies. For this reason, Haydon maintains a team of engineering specialists to provide the reservoir of skill, knowledge, experience, and creative ability necessary to solve industry's timing problems.

When you submit a timing problem to Haydon, it's handled by a team of specialists — *not* an individual engineer. And you can be sure the Haydon Timing Team is equipped with all the electric, electronic, mechanical and manufacturing know-how needed to analyze your requirements and develop the best possible new or modified timing unit for your specific application.

Correctly designed and efficiently manufactured, Haydon timing devices are exhaustively tested before release to a customer. The results are uniformly high quality devices that are known for fine performance, and long life. May we put our Timing Team to work for you?

A few units from the complete Haydon line are shown at the right. Send now for further information, outlining your requirements.

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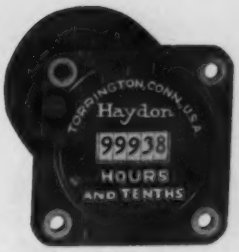
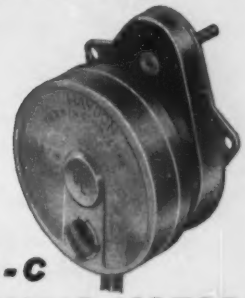


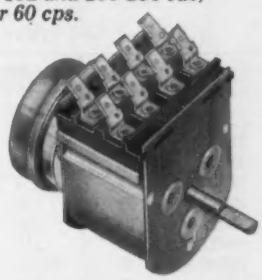
ELAPSED TIME INDICATOR ED-71

Compact, low-cost instrument for machine tools, communications equipment and other commercial applications where an accurate record of operating time is desired. Time Registered: 9,999.9 hours. Weight: 5 oz. Voltages: 120 or 240 v, 60 cps. Power Required: 2.5 watts at 120 v, 60 cps.



A-C TIMING MOTORS

A complete line of synchronous, compact timing motors, speeds from 1/60 to 60 rpm. Guaranteed torques from 6 ounce-inches to 30 ounce-inches at 1 rpm. Voltage ranges 103-132 and 206-264 vac, 50 or 60 cps.



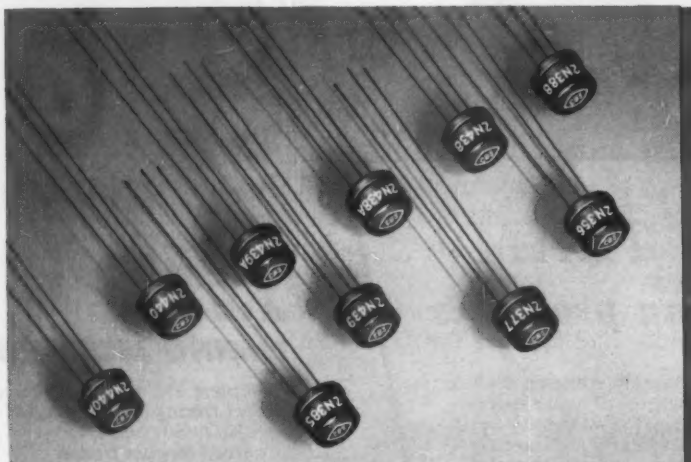
INTERVAL TIMER

Directly controls heavy duty electrical loads. Type AD can be supplied with up to 3 SPST switches. Type AT has 1 SPST switch only. Intervals available with dial and knob: 15, 60 and 180 minutes. Intervals to meet your specific requirements can be supplied. Voltages: 120 or 240 v, 50 and 60 cps. Switch Rating: 28 amps, 250 vac non-inductive; 1 hp, 240 vac.

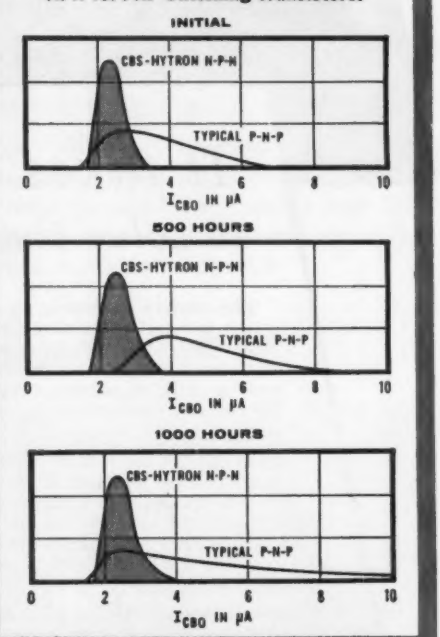
NPN switching transistors PROVE MORE RELIABLE than PNP

Some design engineers specify PNP switching transistors because they consider them inherently more reliable. Actually NPN transistors can give you superior reliability along with their well-known higher speed. Life tests covering hundreds of thousands of CBS-Hytron NPN alloy-junction germanium switching transistors proved this during the past year. See graphs comparing these transistors with typical military-approved PNP transistors.

The superiority of CBS-Hytron NPN transistors is achieved by special processing: For example, advanced surface chemistry techniques seal out moisture and contamination. Precise control of alloying produces high back voltages. Thorough bake-out stabilizes gain. The result is reliable NPN computer-type switching transistors featuring fast switching . . . high voltage . . . low cutoff current . . . and low saturation resistance . . . in a welded JETEC TO-9 package.



Comparative Life Tests
NPN vs. PNP Switching Transistors.



CBS-Hytron NPN Switching Transistors

Type	Minimum BV_{CBO} (Volts)	Dissipation @ 25°C (Milliwatts)	Minimum h_{FE} @ I_C (Ma)		Typical $f_{\alpha b}$ (Megacycles)	Application
2N356	20	100	20	100	3	Core Driver
2N377	25	150	20	200	6	Core Driver
2N385	25	150	20	200	6	Core Driver
2N388	25	150	30	200	8	Core Driver
2N438	30	100	20	50	4	Logic Circuit
2N438A	30	150	20	50	4	Logic Circuit
2N439	30	100	30	50	8	Logic Circuit
2N439A	30	150	30	50	8	Logic Circuit
2N440	30	100	40	50	12	Logic Circuit
2N440A	30	150	40	50	12	Logic Circuit

Operating and storage temperature, T_j = −55 to +85°C

A comprehensive line of these reliable CBS-Hytron NPN high-speed switching transistors is available now in production quantities. Check the table. Order types you need . . . or write for Bulletin E-293-302 giving complete data...today.

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Companies Report Dividends

SHAREHOLDERS of a number of electronics firms are receiving or expecting to receive dividends on their holdings during this first quarter of 1959. Dividend announcements cover payments in cash and in stock. Among firms announcing dividends are:

• **Raytheon Manufacturing Co.,** Waltham, Mass., whose stockholders received a 5-percent stock dividend last week. Company earnings in 1958 amounted to $3.08 a share, as compared with $1.70 in 1957, according to company president C. F. Adams.

• **Television Electronics Fund,** Chicago, shareholders are slated to receive dividend of eight cents a share, payable tomorrow to stockholders of record as of Feb. 2, 1959.

• **Altec Companies, Inc.,** Anaheim, Calif., manufacturers of audio equipment and special transformers, will be sending dividend checks next week to stockowners of record as of Feb. 24, 1959. Dividend rate is ten cents a share as a regular quarterly amount.

• On March 16, stockholders of record of **Magnavox Co.,** Ft. Wayne, Ind., will receive their regular quarterly cash dividend of 37½ cents per share. Persons holding shares as of March 25, 1959, will also receive a special 5-percent stock dividend, says R. A. O'Connor, board chairman. Payment date is April 15.

• **Amphenol-Borg Electronics Corp.,** Chicago, announced its first dividend since the firm was formed last December from a merger of Amphenol Electronics and G. W. Borg Corp. Dividend payments will be 35 cents a share payable March 30 to common shareholders of record as of March 16.

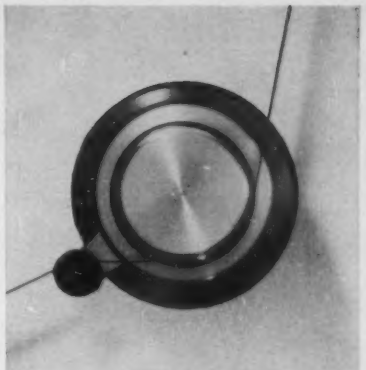
• Shareholders of **Narda Microwave Corp.,** Mineola, L. I., N. Y., received a dividend last week of one share of stock in Narda Ultrasonic Corp., a subsidiary of NMC, for each 100 shares held. Three additional shares of the Narda Ultrasonic stock will be issued as dividends on the same basis during the remaining three quarters of this year.

• **Packard-Bell** stockowners received a dividend last month of 12½ cents per share on the 688,000 common shares outstanding. Dividend was payable to shareholders of record as of Jan. 9, 1959.

OVER THE COUNTER

1958 BIDS LOW	1958 BIDS HIGH	COMMON STOCKS	WEEK ENDING Feb. 6 BID	WEEK ENDING Feb. 13 BID	WEEK ENDING Feb. 13 ASKED
3¾	20½	Acoustica Assocs	22½	21½	24⅝
1⅝	3	Advance Industries	3⅜	3¼	3¾
3⅛	6⅝	Aerovox	7½	7	8⅛
20½	33	Amer Res & Dev	38¼	38½	40¾
16¾	24¼	AMP Inc	24½	24	26¾
5½	15	Appl'd Sci Princet	9¼	9½	11½
1⅛	8⅞	Avien, A	8¼	7¾	10½
6¾	24	Baird-Atomic	26¼	25¼	27¾
9¾	13⅜	Burndy	14	14½	15⅞
6¾	9	Cohu Electronics	7¾	7¼	8⅛
11	22½	Collins Radio, A	23¾	22½	25⅛
10¼	22¼	Collins Radio, B	23¼	22	24⅝
4	7	Craig Systems	7½	6⅞	8⅛
30	50½	Dictaphone	45	43	49
17⅝	25⅜	Eastern Industries	20¼	19	21¾
10½	21	Electro Instr	23½	22½	24⅞
34	49	Electronic Assocs	48	46	53
5	11	Electronic Res'rch	12¼	12¼	14⅛
8½	12¾	Electronic Spec Co	13⅛	13⅜	14⅞
15¼	49½	Epsco, Inc	36	35	40⅞
5½	9⅜	Erie Resistor	10	9¼	11¼
10	17½	Fischer & Porter	15¾	15½	17¼
36¾	50	Foxboro	49½	49½	53½
5½	10½	G-L Electronics	13¾	14	16
12	27	Giannini	26½	26	30⅜
30	39½	Hewlett-Packard	39	37½	41⅛
23¼	48	High Voltage Eng	54½	52	58
1¾	3	Hycon Mfg	3¼	3	3⅞
1⅛	5⅛	Industro Trans'ter	2¾	2¾	3⅝
1½	4¾	Jerrold	4⅞	4¾	5¼
21	30	D. S. Kennedy	36¼	33½	37¾
3¾	29	Lab For El'tronics	26½	26	29⅛
19¼	28	Leeds & Northrup	29¼	28½	32
2	3⅛	Leetronics	2⅛	2¼	2¾
5	18¾	Ling Electronics	18	16⅜	18⅛
16	20½	Machlett Labs	25	24½	26¾
3¼	8¼	Magnetic Amplifiers	7½	7¼	8⅜
2⅞	4½	Magnetics, Inc	3⅝	3⅝	4⅛
4⅝	12	W. L. Maxson	13⅞	13½	15⅜
10⅝	29	Microwave Assocs	34	32	35⅝
5¼	11¾	Midwestern Instr	13⅝	13¾	15⅛
1⅛	7	Monogram Precis'n	8¼	8⅜	9⅛
3½	7¼	Narda Microwave	7¾	7¾	8⅛
9¼	16	National Company	18½	18¾	20⅜
14¼	56	Nuclear Chicago	30½	29¼	36¾
14½	29¾	Orradio Industries	29¾	28½	32
4½	7⅜	Pacific Mercury, A	9⅛	9¾	11¾
10⅛	27½	Packard-Bell	31	29½	33½
4¼	9⅜	Panellit, Inc	6¾	6¾	7⅝
21	53¾	Perkin-Elmer	46½	45¼	49⅞
11⅜	19½	Radiation, A	18¾	18	19⅞
2⅛	7⅜	Reeves Soundcraft	6⅝	6⅞	7⅜
13	32½	Sanders Associates	30	29	33
7	12	SoundScriber	18¾	17¾	19⅝
22¾	40	Sprague Electric	41	39½	43½
26	35	Taylor Instruments	32¾	32½	35⅜
5½	15	Technical Operat'ns	16¼	16¼	18⅞
5½	15¾	Telechrome Mfg	18	16½	19⅝
3¼	7¾	Telecomputing	7½	7¼	9
1⅛	2¾	Tel-Instrument	2¾	2¾	3½
8¾	16¼	Topp Industries	14¾	13¼	15¾
3¾	10¾	Traceriab	10¼	10	11¼
1¼	3⅜	Universal Trans'tor	1	1	1⅜
14¼	40	Varian Associates	43	40	45⅜
12½	18½	Vitro Corp. Amer	15⅞	15⅜	16⅞

The above "bid" and "asked" prices prepared by the NATIONAL ASSOCIATION OF SECURITIES DEALERS, INC., do not represent actual transactions. They are a guide to the range within which these securities could have been sold (the "BID" price) or bought (the "ASKED" price) during preceding week.



AMPEX:
turning point for tape

Magnetic recording has reached the point where a better tape, by itself, can significantly improve the performance of your equipment. Anticipating this, Ampex has developed its Instrumentation Tape to assure the highest capability that the state of the art requires.

Precision tape reliability comes principally from the properties of its coating. And Ampex combines oxide preparation and careful coating techniques with the exclusive Ferro-Sheen process to produce the smoothest, most cohesive, most uniform of precision tapes. The result is measurably higher signal-to-noise ratios, and much less tape wear.

This, with its squared-up hysteresis curve, makes Ampex Instrumentation Tape ideal for all recording systems: direct, FM-carrier, PDM, and NRZ-digital.

Ampex Instrumentation Tape is available on hubs, NAB-type or die-cast magnesium - alloy Precision Reels. Widths of ¼", ½" and 1" are standard on either Mylar* or acetate base, in the following lengths, reel diameters, and base thicknesses:

AMPEX STANDARD TAPE LENGTHS (feet)

REEL DIAMETER	BASE THICKNESS (mils) 1.0	1.5
7"	1800	1250
10½"	3600	2500
14"	7200	5000

*DU PONT TRADEMARK

For complete specifications or additional tape literature, write

AMPEX MAGNETIC TAPE

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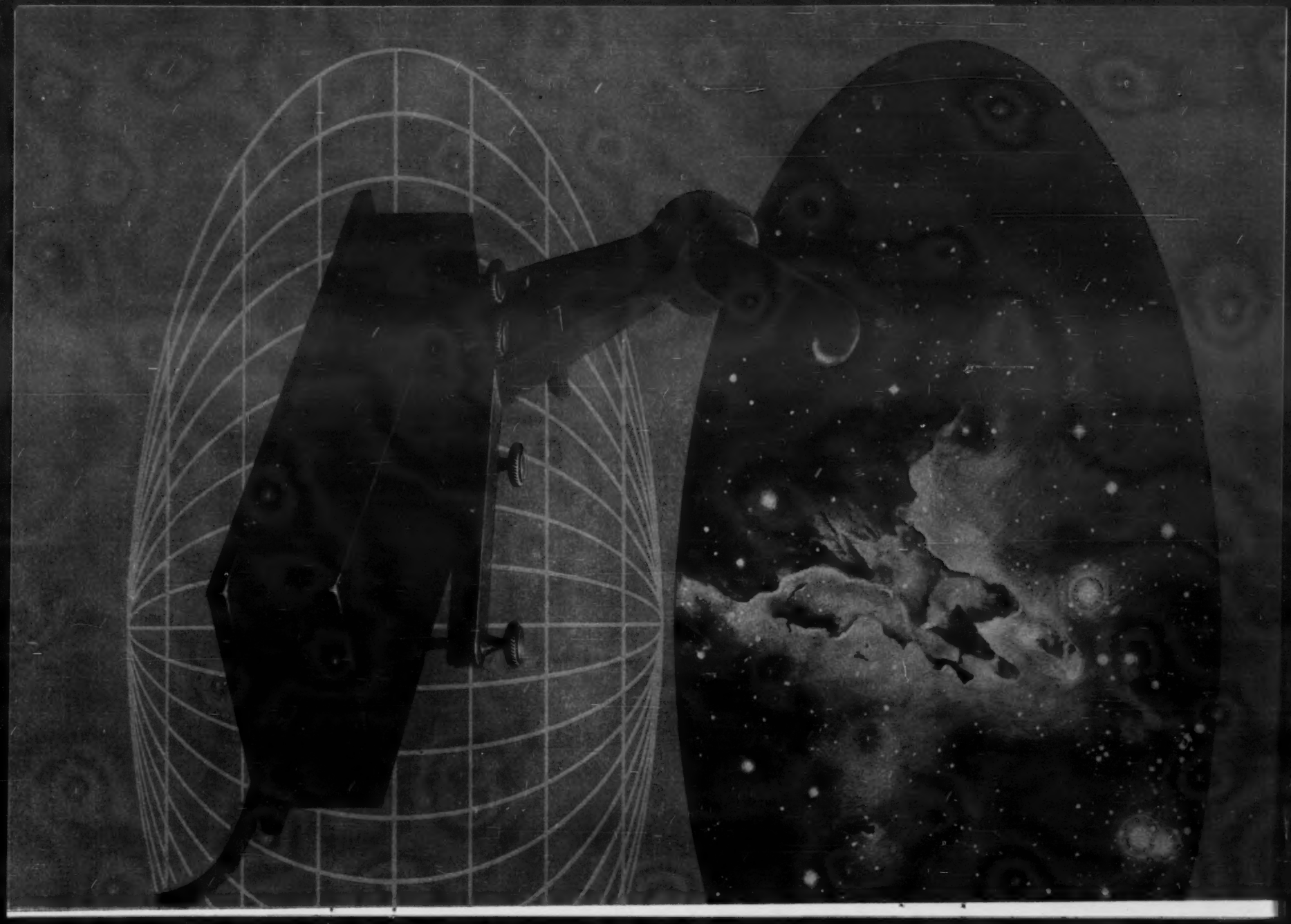
CIRCLE 18 READERS SERVICE CARD



SPACE COMMUNICATIONS: As man's explorations reach further into outer space, it becomes necessary to make great improvements in communications. One of Lockheed's many contributions in this field is a miniaturized satellite tape recorder, able to store three million pieces of scientific data anywhere in its travels and on return to range of earth stations, transmit it on command. Marconi's original sending key depicts man's first successful attempt to communicate by wave impulse.

SPACE COMMUNICATIONS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Lockheed's activities in the missile field began before World War II when the company designed and flew a pilotless aircraft for the Army Air Corps. Today the Missiles and Space Division embraces every facet of research and development, engineering, test, and manufacture. It has complete capability in more than 40 areas of science and technology, from concept to operation.

The Division is engaged in basic research and development in such major fields as: nucleonics; electronics; propulsion; physics; chemistry; mathematics; computer development; oceanography; reconnaissance; aero-thermodynamics; magnetohydrodynamics; operations research and analysis; human factors; space communications; and materials and processes.

Programs such as the Navy Polaris FBM; Discoverer Satellite; Army Kingfisher; Air Force Q-5 and X-7 reach far into the future and require a bold and imaginative approach where only theory now exists. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. B-22, 962 W. El Camino Real, Sunnyvale, California.

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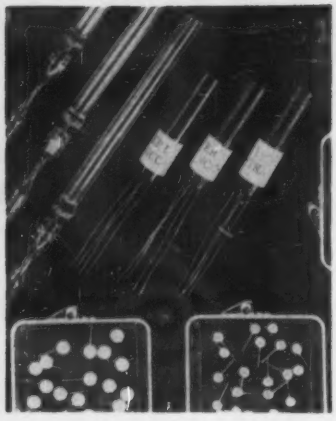

Let our scientists, with ten years experience in developing and using solions in defense projects, help you with your application of the new solion integrators announced in this issue.

In addition to Solion Development TRA conducts contract research and development for clients in the following fields.

- **ELECTRONIC DESIGN**
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Austin 1, Texas

CIRCLE 21 READERS SERVICE CARD

Firms Seek R&D Budget Data

MARKETERS OF ELECTRONIC PRODUCTS are intensifying efforts to determine how much competitors and other members of the industry are spending on research and development. Reason for this: Control R&D spending and keep up with competition in the new products race.

Facts on R&D expenditures for individual firms are often regarded as hard-to-get. But in cases where firms have put out a new security issue, data can be gotten from the security prospectus, available from underwriters. Moreover, Securities & Registration Commission penalties for false statements add authenticity to the figures.

• **Examples** of prospectus R&D information includes **Addressograph-Multigraph's** listing of annual R&D expenditures from 1954-1958—ranging from 1.9 to 2.7 percent of sales. **Thiokol Chemical** reports that in 1957 it spent seven percent of its sales on commercial development. **Smith-Corona** notes that it plans to spend $1,250,000 in the 1958-1959 period for operating and capital expenses of its research and development program.

Prospectus often contains information on competitor sales by product lines and as a share of the total market. Recent **Electro-Voice** stock issue reports that microphones accounted for 18 percent of total sales for first nine months of its 1959 fiscal year, which ends this month, compared with 23 percent for 1958. **Perkin-Elmer** prospectus of Nov. 7, 1957, contains estimate that company commands two-thirds of the infrared spectrometer market, a quarter of all process control analyzer sales and about one-tenth of the market for ultraviolet spectrometers.

• **Substantially** larger sales of electronic pleasure boat equipment are coming, manufacturers say. They point out that less than 70,000 of some 481,000 registered inboard and large outboard motor boats have radiotelephone equipment. Also, the entire outboard market, numbering in the millions, has scarcely been tapped.

Estimates of 1958 pleasure boat electronic equipment sales range from $5 to $6 million. Biggest share of sales came from radiotelephones, 25 to 35 percent of the total. Next most important sales items are direction finders and depth sounders.

An important factor in the optimistic sales forecasts is expectation that more and more low-cost items will be developed to attract outboard boat owners. Number of manufacturers featured low-cost citizens band radiotelephone equipment at recent motor boat shows.

• **Small business** received about $4.2 billion in payments for defense subcontracts in fiscal 1958, as against $3.6 billion in fiscal 1957, Department of Defense reports. Small firms also received $3.729 billion in military prime contract awards, compared with $3.783 billion for 1957.

• **General Electric Heavy Military Electronics Department** sets up two new marketing units in an effort to better its position in winning big subcontracts from defense prime contractors. The new departments—Defense Industries Sales and Defense Industries Contract Administration—will strive to bring GE's abilities to design and produce large complex electronic subsystems to the attention of military prime contract market.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

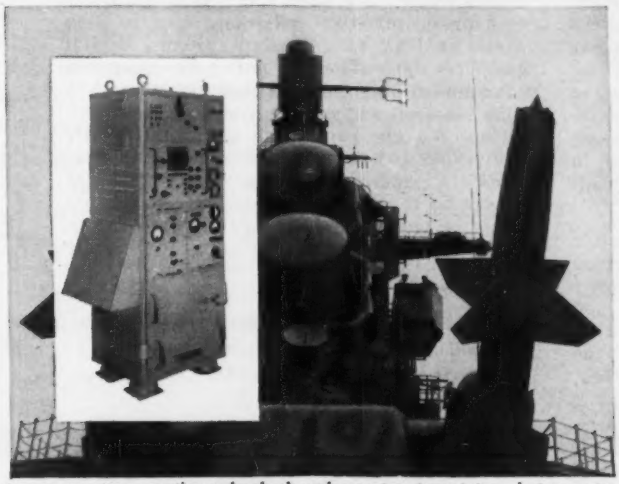
(Source: EIA)	Feb. 6, 1959	Jan. 9, 1959	Change From One Year Ago
Television sets	129,499	91,212	+24.8%
Radio sets (ex. auto)	290,190	254,021	+29.5%
Auto sets	107,905	107,875	+40.5%

STOCK PRICE AVERAGES

(Standard & Poor's)	Feb. 11, 1959	Jan. 14, 1959	Change From One Year Ago
Electronics mfrs.	72.26	75.40	+37.3%
Radio & tv mfrs.	79.22	83.20	+73.9%
Broadcasters	81.47	78.42	+43.1%

Production-testing with Sperry-designed equipment assures that your product meets specifications and quality standards.

Maintenance of critical avionic systems is fast and accurate with compact automatic check-out equipment.



In-use monitors continuously check and report system status, alert operator to malfunctions and provide maintenance data.

To assure reliability . . .

Sperry electronic test equipment designed to your specifications

Every engineer knows how relentless is the pressure from both military and industrial customers for *increased reliability*. And making sure a new weapon system, for example, is operable at an instant's notice calls for test equipment as advanced as the system itself.

You'll be glad to know that now you can obtain advanced test equipment tailored exactly to your needs from Sperry's new Microwave Electronics Company. You will save valuable design and development time . . . free your engineering staff for other jobs—and enjoy the benefit of Sperry's 20 years of experience in designing, developing and producing complex radar and other electronic test equipment.

Whether you need equipment for production testing, maintenance or in-use monitoring, Sperry can meet even the most rigid specifications. Built into it will be the newest Sperry concepts of dynamic system evaluation and signal simulation . . . the precision measuring techniques that today are providing reliable and accurate automatic testing of the B-58 Hustler supersonic bomber and similar complex systems.

With the pressure on for electronic-system reliability, now is a good time to turn over your testing equipment research and development problems to the specialists—Sperry Microwave Electronics Company. Write today for details.

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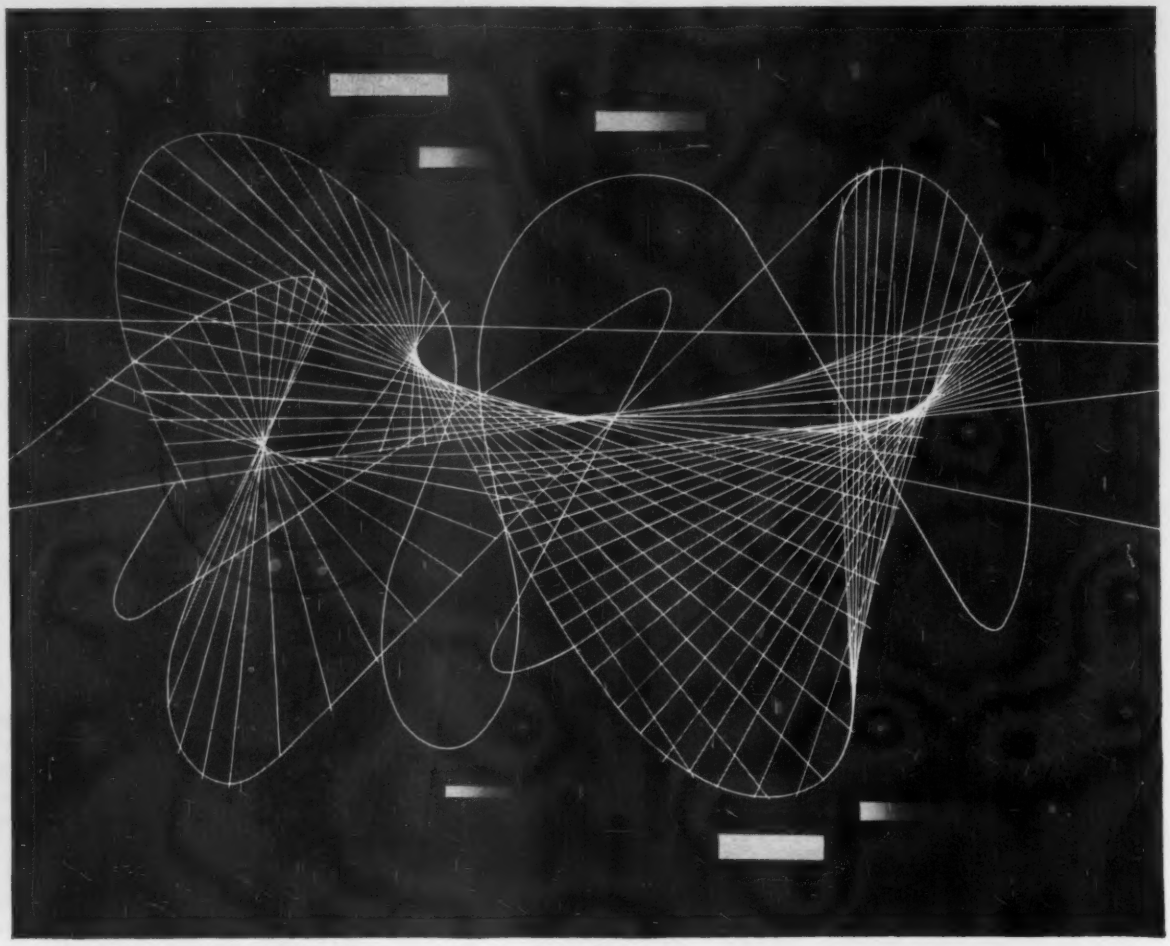
***Address all inquiries** to Clearwater, Florida, or Sperry Gyroscope offices in New York • Cleveland • New Orleans • Los Angeles • San Francisco • Seattle*



WHEN A COMPANY OUTGROWS ITS NAME

As the domestic research organization of the world-wide International Telephone and Telegraph Corporation, we are carrying on our tradition of pioneering in electronics. As our engineering responsibilities have increased so our organization has grown. Today, in addition to our main laboratories in New Jersey, laboratories in Ft. Wayne, Chicago and in California are pursuing projects of great magnitude and importance.

You will find in our staff the same fine creative thinking and engineering imagination which brought distinction to our old names. Formerly Federal Telecommunication Laboratories and Farnsworth Electronics research laboratories, our names have been changed to identify us clearly with our parent company, and to reflect our expanded responsibilities and growth.

Electronic engineers will find here opportunity to express initiative and competence in such areas as long range radar systems, digital computer applications to data processing and communications, space technology, microwave tube research and missile systems instrumentation. We are continuing our work in air navigation and control, and in electronic systems . . . and making new contributions to electronic theory and techniques. In fact, it would be hard to find another research organization that offers the engineer such a wide scope of activities.

Engineers interested in discussing professional positions with our staff are invited to write Mr. T. C. Allen, Manager, Professional Staff Relations.

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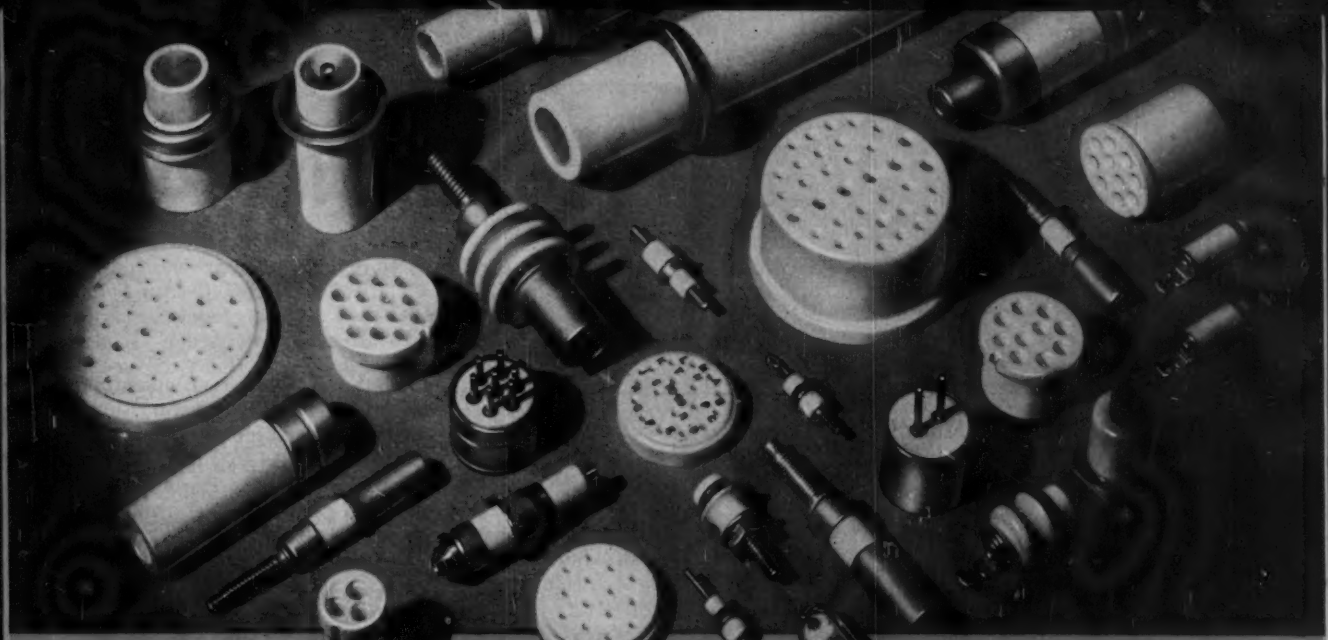

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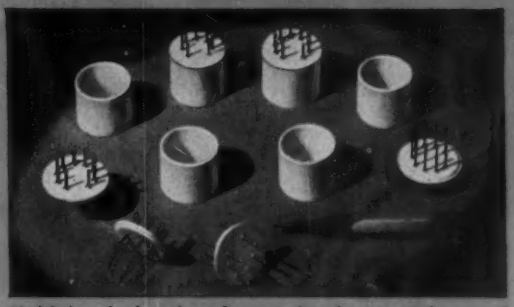
AlSiMag high-alumina ceramics offer unusual reliability. High temperature resistance, superior insulating characteristics, great mechanical strength, resistance to abrasion, corrosion and chemical attack are among the advantages particularly important when maximum performance and reliability must be packed into minimum space.

Both soft solder and hard solder terminals are available. A new technique is producing strong high temperature metal-ceramic hermetic seals.

Precision tolerances can be maintained. Custom designs are made in an unusually broad range including ultra-thin or miniature components of unusual complexity.

AlSiMag special purpose compositions based on alumina, steatite, zircon, Forsterite, cordierite, titania, aluminum silicate, magnesium silicate, silicon carbide and other materials may answer special requirements. The AlSiMag family of ceramic compositions is the largest in the industry... and it is backed by more than half a century of specialized experience over the widest area of design and production in the technical ceramic field. Your inquiries will have prompt and interested attention.



Multiple pin headers for use in electron tubes and other demanding applications are made in AlSiMag with pins hermetically sealed. The AlSiMag ceramic may be safely used in working temperatures up to 2800° F. The limiting factors are the metal components. The parts shown have tantalum pins with nickel braze alloy combined with the ceramic in a strong hermetic seal for operating temperatures in the 1000° F. range. The materials have been carefully selected for ruggedness and for their low vapor pressure characteristics. This base and envelope allow higher bake-out temperatures during assembly.

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Debate Worldwide Air Nav-Aid

International Civil Aviation Organization divides into two camps over short-range air-navigation system for world's civil airlanes

MONTREAL, QUE.—DEBATE here over which short-range navigation standard should be adopted for worldwide implementation in the civil airways may have officially ended by the time this issue reaches readers.

But the argument won't actually be settled for quite a while. And some bitterness will be left after the settlement, no matter which way it comes.

International Civil Aviation Organization, meeting here to resolve the long-smoldering dispute between adherents of Vortac rho-theta and Decca hyperbolic systems, was divided into the two camps before the sessions even started on Feb. 9.

Pros and Cons

Britain's aviation ministry and most of the British carriers focused the argument for Decca Navigator's system. The U. S. Federal Aviation Agency (unofficially) and most American carriers plumped for the existing VOR system with Tacan-compatible distance-measuring equipment.

Thirty-two member nations attended the Montreal meeting. Included were a number of smaller countries — Colombia, Nicaragua, Ecuador, Bolivia, among others— that rarely if ever had attended an ICAO technical meeting. That fact prompted the British representatives to suspect the U. S. of packing the house.

The British argue that the Decca system is the only logical solution for high-density areas with the coming of jets. U. S. rebuttal is that most high-density areas are in this country; if Vortac works here, it can work anywhere. British counter by pointing out that New York's International Airport (Idlewild) is overloaded whenever conditions are other than ideal, and that with jets the situation would become both chaotic and costly.

VOR (vhf omnirange) has been ICAO standard as a short-range navigation aid to provide bearing data since 1949. The civil distance-measuring equipment adopted on ICAO's recommendation since then is not generally compatible with the military Tacan system. DME installed as part of this country's Vortac (or VOR-DMET) system, however, does conform to Tacan characteristics.

Large Investments

Technical and philosophical arguments put forth at this hassle mask what are actually economic reasons.

This country and its flag carriers have a large investment in the Tacan system, in VOR, and—reently—in Vortac. Most of the commercial carriers in the International Air Transport Association back the U. S. position: for IATA members, Vortac is the easy way out. U. S. military interest in keeping distance-measuring gear compatible with Tacan gives IATA members a price break on airborne Vortac equipment.

British carriers—especially British European Airways—have invested heavily in the Decca short-range and Dectra long-range equipment. And, unlike FAA (which officially has taken no stand in the argument), Britain's government body, the Ministry of Transport & Civil Aviation, has officially been "convinced that only the Decca navigator can provide a satisfactory answer to the growing problem of crowded airways."

Decca has installed 13 "chains," of which eight are in Europe blanketing the United Kingdom and the continent from the iron curtain to the Pyrenees. Four more are in Canada, and one in the U. S. (in the New York area undergoing FAA test). Each chain comprises three or four stations: one master and two or three slaves.

By comparison, some 1,500 VOR stations are planned or operating around the world. Several European manufacturers are turning out VOR gear. NATO nations lean toward Vortac, since Tacan already serves as part of NATO's military air control.

Decca claims that it could blanket the U. S. for about the amount of money that it now costs annually to maintain the VOR and Vortac equipment here.

System Differences

Decca promoters point out that Decca works well with the long-range Dectra, now in field trial over the Prestwick-Gander air route. Vortac adherents counter that the instrument-landing systems in use all over the world work better with Vortac-type gear.

System differences are used as arguments in the hassle. Decca is a low-frequency hyperbolic system, gives cockpit data in terms of dial readings that—like loran—must be transferred to a chart. Accuracy of the system decreases with increasing distance from the ground stations. An automatic-plotting flight

First production line photo shows Atlas ICBM's in Convair's San Diego plant. Stainless steel Air Force missiles—75 ft long, 10 ft in diameter—are nested in elevated docks. Electronic checkout gear is in area underneath

log now permits the pilot to observe his course and ground position continuously on a chart.

Vhf omnirange system presents cockpit data in direct-reading dials which give angle to ground beacon, and periodically identify the beacon. Related DME-T gear gives direct dial reading of miles to the beacon. There is a cone of ambiguity over the VOR station because of the antenna propagation pattern, but no ambiguity in dial interpretation. Accuracy is ±0.2 miles independent of distance over the range of the beacon.

Decca master and slave stations, transmitting in effect continuously, set up a lattice of hyperbolas, each of which represents the locus of equal phase-difference between any two stations.

VOR broadcasts two signals from a common antenna array, one signal constant in phase, one varying in phase as the antenna array is rotated. Automatic gear reads the phase difference and derives bearing information in terms of this difference. Related distance-measuring gear is a radar beacon interrogated automatically by the craft. Transponded signal from the ground is received in the plane, its delay from interrogation-time measured, and the difference translated into a dial reading.

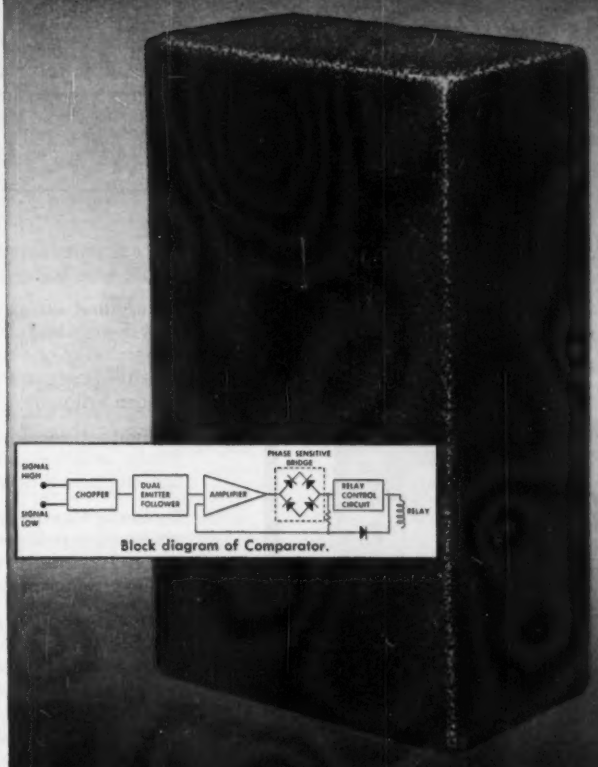
Operating Ranges

Range of Vortac beacon is about 200 miles. Range of the Decca system is somewhat greater: the ideal baseline length from master station to slave is about 70 miles, and the coverage area extends about 100 miles around each slave. This range—and the accuracy of the reading—are reduced at night as skywave characteristics change.

U. S. opinion of Decca system is colored by the lack of what aviation people here regard as exhaustive field trial. The Decca chain installed in the New York area is being tested only for helicopter traffic, and only within the triangle formed by the slave stations. One aviation expert told ELECTRONICS "we need to test the system with fixed-wing craft in fairly dense traffic, and we need to know more about what happens on the periphery of the coverage area."

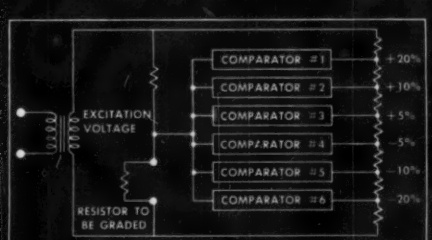
for "GO-NO GO" automatic monitoring / control . . . new trio labs'

ALL-TRANSISTOR VOLTAGE COMPARATOR



ACTUAL SIZE

Block diagram of Comparator.



A typical application of the Comparator in an automatic resistor grading system.

SPECIFICATIONS

AC Sensitivity: 5 MV
DC Sensitivity: 10 MV
Input Impedance: 2 Megohms (min.)
Output: DPDT relay, contact rating 2 Amps. at 28 V DC
Power Requirements: 115V, 400 cycles, 1 watt
Repeatability of Trip Point: ±1 MV
Performance will meet or exceed appropriate MIL specifications.
AC or AC-DC versions available.

Series 200 trips its own DPDT output relay when an unknown input signal exceeds the value of a known input reference level. This direct voltage comparison is the most reliable technique for automatic, programmed accurate measurement with computer-speed. Applications, virtually unlimited, include: military ground support devices, airborne instrumentation, production test equipment, alarm/control systems, and many data-gathering and processing systems. Write for reprint of article in "Military Systems Design" magazine. Also for Tech Bulletin. Address Dept. E-2.

Trio Laboratories, Inc., Plainview, Long Island, New York.

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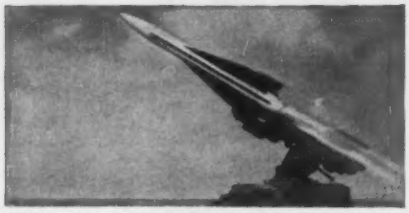
Raytheon Missile Projects

SPARROW III—the Navy's tenacious, lightning-fast, air-to-air missile—is intended for extensive use by Navy fighter aircraft in fleet air defense. Sparrow III is a Raytheon prime contract.



HAWK—the Army's defense against low-altitude attackers—carries out its destruction in the blind zone of conventional radars. Hawk development and production is under Raytheon prime contract.

TARTAR—A substantial contract for vital electronic controls for this Navy destroyer-launched missile is held by Raytheon. This equipment—a tracking radar and associated units—enables it to "lock on", cling to target's path, despite evasive tactics.

ADVANCED PROJECTS in aeronautical structures as well as missile guidance and control are now underway in Raytheon laboratories. New facilities are continually being added for this work.

PRELIMINARY NEW DESIGNS of tomorrow's missiles will result from the advanced work being done by today's missile engineers. Raytheon plays an important role in this area.

Raytheon diversification offers

JOB STABILITY FOR CREATIVE MISSILEMEN

Here is an opportunity to free yourself of worry about a job that's here today, gone tomorrow.

Diversified assignments—only possible in a company with Raytheon's wide range of missile activities—means security not found in one- or two-project companies. You apply your creative energies to the many projects you work on, and they in turn are your "insurance" against falling into a rut.

Individual recognition comes quickly from Raytheon's young, engineer-management—men who are keenly aware of the engineer's needs and contributions to missile progress.

Dynamic Raytheon growth—the fruit of this management's progressive policies—is best illustrated by the fact that Raytheon is already the only electronics company with two prime missile contracts—Navy Sparrow III and Army Hawk.

The next step is up to you. Why not get frank answers and helpful information on the type of job suited to your background and talents, its location, salary and other important details. Write, wire or telephone collect: The number is CRestview 4-7100 in Bedford, Massachusetts. Please ask for W. F. O'Melia.

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Silicone rubber wire insulation withstands soldering heat without damage

Thanks to silicone rubber's remarkable heat resistance, no damage occurs when you lay a hot soldering iron on silicone-rubber-insulated wire. And silicone insulation strips cleanly and easily, saving hours of assembly time in the plant. Right-angle bends are no problem. Colors are bright for easy identification.

Long service life at 500°F Withstands 600°F and above for shorter periods. General Electric silicone rubber insulation meets military specifications MIL-W8777A, MIL-W16878B and others. When exposed to a direct flame, it forms a non-conducting ash of silicon-dioxide, releasing no toxic fumes, as do higher-priced insulating materials.

Will not cold flow Because silicone rubber is a *true* elastomer, it will not cold flow and subject wire to vibration, as will higher-priced insulating material. Newly developed stocks make possible thin-wall construction, have unusual abrasion resistance and physical strength. G-E silicone rubber stays flexible down to −75°F, special grades down to −150°F.

Greater reliability G-E silicone rubber exhibits excellent electrical properties and maintains them at both high and low temperatures, keeping its original dielectric strength for years. Moisture absorption is extremely low; ozone resistance approaches that of mica.

General Electric silicone rubber insulation matches or exceeds the vital properties of insulation costing three times as much. Find out what it can do for you. Mail coupon for technical data.

GENERAL ELECTRIC

Silicone Products Department — Waterford, New York

Section R8CC2, Silicone Products Dept.
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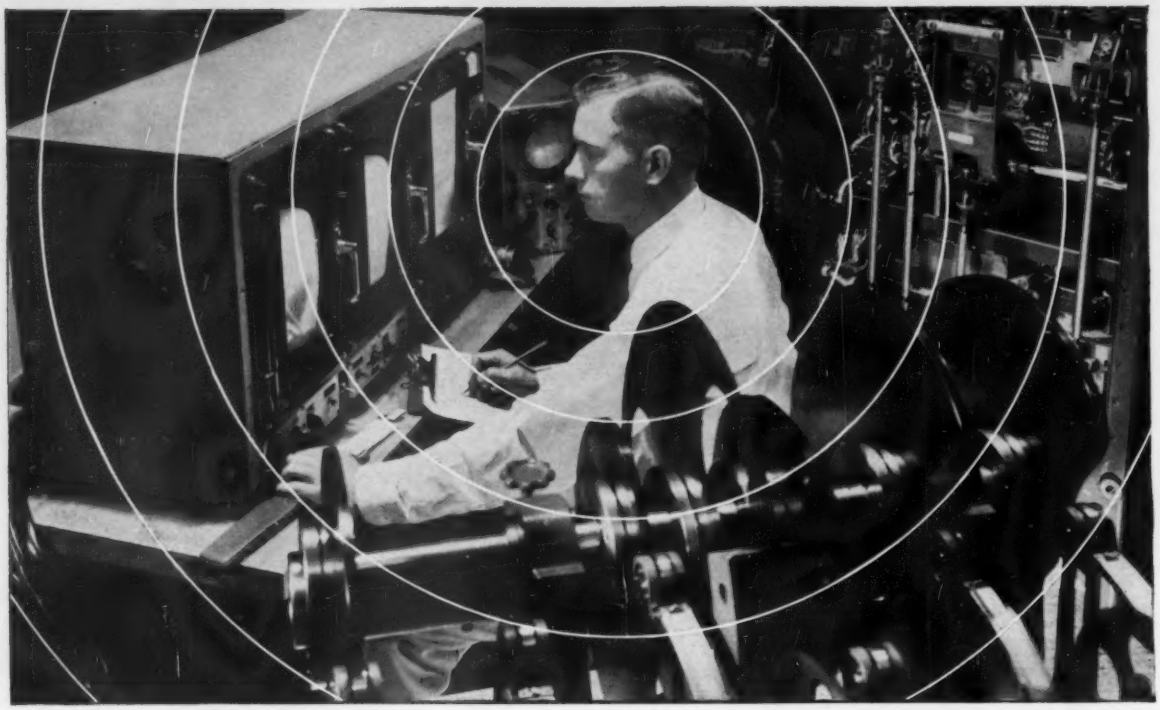
Please send me more information on wire insulated with G-E silicone rubber.

Name_____ **Position**_____

Company_____

Address_____

City_____ **Zone**_____ **State**_____



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Talk to the people at AC about it soon. Just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Box 746, South Milwaukee, Wisconsin; or Mr. M. Levett, Dept. A, 1300 N. Dort Highway, Flint 2, Michigan.

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AC SPARK PLUG ❀ THE ELECTRONICS DIVISION OF GENERAL MOTORS

SAC Buys Automated Control

Strategic Air Command's new electronic system takes data from the field, processes and displays it in one continuous automatic operation

OFFUTT AFB, NEB.—Strategic Air Command's combat control system, already heavily electronic, is going to be even more so.

A new electronic complex, now under development, will eliminate the human steps between data acquisition, processing and display. Information will flow directly from the field to headquarters' display board—untouched by human hands.

Here's how SAC's present and future systems operate:

If America should be attacked, a single voice command of a few seconds duration would immediately throw the Strategic Air Command's plan for global retaliation into action. The order would be given from SAC's underground headquarters here, over the red telephone that provides instantaneous voice contact with all SAC command posts.

Data Required

To integrate such an assault by bombers and tankers rising from four continents and, in the future, by surface-to-surface missiles launched from the U. S. and Europe, a staggering volume of data must constantly be on hand. Thousands of vitally relevant details must be kept current and selectively accessible within seconds. Handling this job at present is an IBM 704 electronic data-processing system.

Information stored in the 704's magnetic core includes:

- Performance characteristics of each of SAC's 3,000 planes; maximum range without and with refueling; location and operational status of each bomber and tanker; crew, supply and maintenance facilities at each base.
- Distance to all potential targets from designated bases; where tankers must intercept each bomber; where reserve tankers are located in the event a tanker base is knocked out.
- Size, configuration and importance of each target; damage yield of bombs in inventory; percentage, and sector, of each target that would be destroyed, calculated for where the bomb hits.
- Time and space interval to be maintained between planes dropping nuclear bombs. Using the 704's calculations, take-off times of all bombers can be staggered so that no two paths will cross too close to radioactive areas.

Computer's Role

With such information, the 704 helps to:

- Write war plans.
- Control the force (keeps tabs on compliance with plan).
- Keep score on objectives in war plan actually realized and those aborted.
- Compute immediate damage assessment (IDA), and to . . .
- Replan the attack.

Progress of the strike force is recorded by means of punched cards. New information is processed automatically, providing constant knowledge of the status of the strike force. A tanker base, for example, might be knocked out by an enemy ICBM after the bombers depending on the base for refueling have taken off. The computer, on interrogation, tells locations and readiness status of substitute tankers. Next question—which bombers could not be intercepted for refueling and therefore not get back from the target—is also answered.

War orders can go to all command posts over red telephone

Present system for getting data from the field into headquarters, and processed and posted on the control room's panel, will not be adequate for the added discipline a mixed missile/bomber force will require. To make the system completely automatic from field to control room panel, the International Electric Corp., a new unit set up by the International Telephone and Telegraph Corp., is developing a world-wide electronic combat control system. Designated the 465-L, the system consists of communications, data-processing and data-presentation sub-systems.

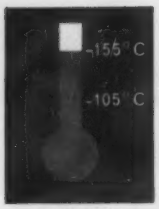
Basic information on the movement and status of SAC weapon systems is introduced into the system at operational level by an information feeder facility. Data is converted into high-speed digital bits and sent into headquarters by wire. Here, it is automatically processed and sent to animated display panels, or else stored for future use.

Data-processing subsystem for the 465-L is being developed by IBM under subcontract from ITT. Transistorized and using ultra-high-speed magnetic memories, the new system will be far more powerful and faster than the 704 and will have greater storage capacity.

Another advantage of the 465-L over the 704 lies in a priority interupt capability. Interrogation and/or output can be interrupted for a different and more urgent request. The 465-L will be capable of synchronous operations—input, out- and computations.

For automatic communication between bases, the feeder system will provide automatic traffic control centers which will route information, recognize priorities and obtain acknowledgment from all addressees that messages have been received.

Though dollar figure for ITT's contract has never been disclosed, it probably runs close to $165 million.

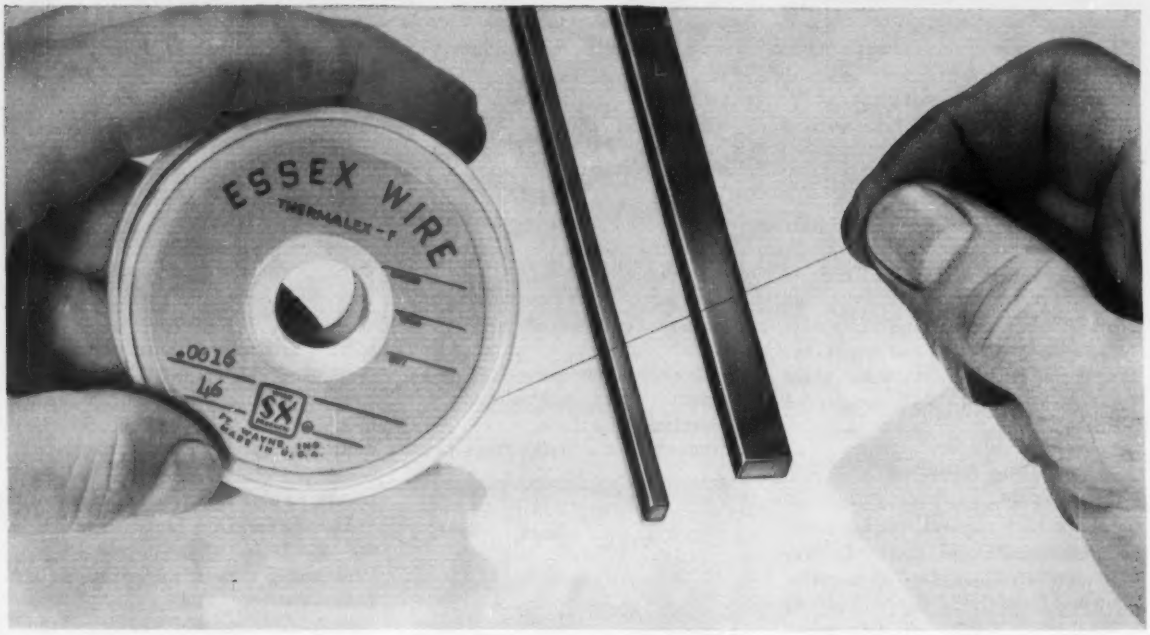


ESSEX

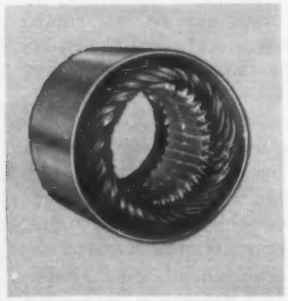
Now...all sizes and shapes of SX Magnet Wire for every "hot spot" application

Thermalex-F

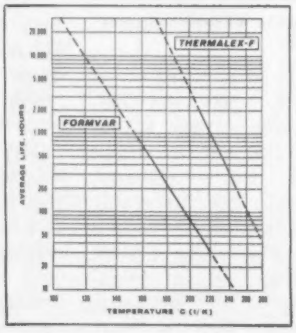
MAGNET WIRE — *Class F (155°C)*



Rounds, squares and rectangulars also available with single and double glass coverings



VERSATILE GENERAL PURPOSE APPLICATION
Thermalex-F is not a special wire but has properties required for a general purpose application and can be used through the 105°C-155°C temperature range... Class A applications as well as Class F... eliminating the need for buying more than one type of magnet wire.



OUTSTANDING THERMAL STABILITY
A.I.E.E. #57 "Procedure for Evaluation of the Thermal Stability of Enameled Wire" which is an accepted test, indicates a 30,000 hours life at 170°C for unvarnished specimens.

Thermalex-F, a Class F (155°C) magnet wire insulation developed by Essex, is now available in round wire from 11 to 50 AWG size and all Formvar sizes of square and rectangular. This full size range gives every manufacturer the versatility he needs in one insulation type for his exact application!

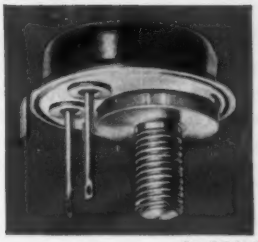
THE WIRE DESIGNED WITH THE FUTURE IN MIND

Magnet Wire Division
ESSEX WIRE CORPORATION
Fort Wayne, Indiana

Manufacturing Plants: Birmingham, Ala.; Anaheim, Cal.; Fort Wayne, Ind.; Hillsdale, Mich.

National network of Warehouses and Sales Offices ... Call your local "Essex Man."

HIGH efficiency at HIGH operating temperatures



SILICON POWER TRANSISTORS

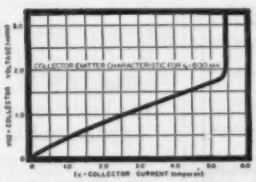
Available Now in production quantities!

The Westinghouse Silicon Power Transistor pictured above is a highly efficient device which greatly increases the range of applications for transistors which must operate without high losses in the "true power range." Thanks to a remarkably low saturation resistance—less than .750 ohms at 2 amperes and .5 ohms at 5 amperes—these transistors possess very low internal dissipation, and can be efficiently used in applications where they must handle as much as 1000 watts. For example, as a DC switch, handling 750 watts (150 volts at 5 amps) the internal dissipation is about 9 watts, with an efficiency of better than 99%.

Additionally, and unlike germanium units which are limited to approximately 85°C, these transistors can operate in ambient temperatures up to 150°C. Thus, even where the higher power rating is not required, these units may be used for their high temperature capabilities.

There are a great many applications for which this new type of silicon power transistor is ideally suited. It will find use in inverters or converters (AC to AC; AC to DC; DC to AC; DC to DC), regulated power supplies, servo output, and other aircraft circuits, as well as in certain amplifiers and switching applications.

Westinghouse Silicon Power Transistors are available in 2 and 5 ampere collector ratings. Both of these are available in 30, 60, 100, and 150 volt ratings in production quantities for your immediate applications. Sample quantities are available in voltage ratings up to 300 volts. Call your Westinghouse representative or write directly to Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pennsylvania.



LOW SATURATION RESISTANCE

Important improvements in silicon purification and transistor fabrication have produced a new series of Westinghouse Power Transistors of exceptionally low saturation resistance.

YOU CAN BE SURE...IF IT'S

Westinghouse

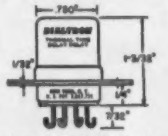
by DIALCO

Hermetically Sealed

Rugged—built to meet conditions of

high altitude
high vibration
high temperature

DIALCO RELAYS exhibit no resonance from 5 to 1,000 CPS at 10 G's; are not damaged by 50 G's shock; are fully compensated for temperatures from –65° C to + 125° C.
Available in delays from 1 to 300 seconds; heater voltages up to 150 V. interchangeable on DC or AC of any frequency with a power drain of 4 watts. SPST normally open or normally closed contacts are rated at 6 amps at 115 V. AC or 3 amps at 28 V. DC resistive.



SUB-MINIATURE
Lightweight (3/4 oz.)
Standard 7-pin plug-in or solder terminals with mounting flange

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CIRCLE 31 READERS SERVICE CARD

Off-Hours Medical

Telephone engineers develop instruments for University of Chicago Medical School

CHICAGO—TELEPHONE engineers here are working as an off-hours volunteer group with the University of Chicago Medical School to develop medical research instruments. Four devices are being used or tested by doctors after little more than a year since the effort began.

The group, consisting of about 40 engineers from the Illinois Bell Telephone Co., calls itself SAVE (for Service Activities of Volunteer Engineers).

Leroy J. Ryan, SAVE president, says the idea for the group came from W. V. Kahler, president of Illinois Bell and a trustee of the University of Chicago.

Ryan told ELECTRONICS he hopes that Bell System engineers in other parts of the country, as well as retired telephone engineers, may join the effort.

"We're making the circuitry and design information available to anybody," says Illinois Bell president Kahler. He adds that if any developments of the group have application in the communications industry, his company would reserve the right to them for such use.

So far SAVE can point to the following accomplishments:

• Three-ounce heartbeat recorder which can be worn over the chest 24 hours a day. It provides medical researchers with cumulative pulse data on a patient's heart.

Unit uses 1-3/10 volts at only 1/4000th of an ampere. Two noise-free silver electrodes pick up microvolt signal developed with each heartbeat. Output from four-stage transistor amplifier operates a watch whose dial is adapted to count heartbeats instead of time.

• Cytodiagnostic training apparatus. Equipment, which can be held in a suitcase, can be used to teach technicians and students to recognize about 24 factors that determine if a cell under a microscope is cancerous. Punched card is put in tester for each specimen slide. Student evaluates slide, then keys his diagnosis on tester. Gear indicates whether diagnosis of cell is correct or not.

• Cumulative electronic calorimeter. This device measures changes in body heat useful in metabolism studies. Unit weighs less than three ounces, including watch and power supply, is shock-proof and runs continuously for more than 24 hours; transistorized amplifier puts out 1 volt.

• Electronic stethoscope. Transistorized device, with circuitry similar to that of the cumulative heartbeat recorder, gives doctors quick visual or audible check on pulse rates during surgery. Beep or flashing lamp operates at same speed as the heart beats.

X-15 to Begin Air Tests

X-15 MANNED ROCKET ship is due for an early series of airborne tests, starting with a "captured flight" aboard a B-52. On-the-ground tests are being completed.

Sponsored by the National Aeronautics and Space Administration, Air Force and Navy, the X-15 was rolled out late last year by North American Aviation.

Spokesmen say information on the test program will be disclosed on an "after-the-fact basis." However, it is understood that X-15 flight tests will start with glides, followed by powered flights from the B-52 at progressively higher altitudes until the craft's maximum design limits are reached.

The flights may provide data on effects of Mach 5 speeds on radio communications. Collins Radio Co., Cedar Rapids, Iowa, designed X-15's system for communications

and automatic direction finding.

A transceiver in a pressurized case provides the basic communication between the X-15 pilot and the mother ship, chase planes and ground stations. This transceiver, model AN/ARC-52, has frequency range of 225.0-399.9 mc, power output of 20 watts, says firm, with 1,750 frequencies available for easy set-up of 20 channels.

Operating independently of the transceiver, but located in the same case, is a guard receiver tuned to a predetermined frequency. The guard receiver controls diversity switching between upper and lower antennas on top and bottom of the fuselage.

Collins says the communications part of its system is designed to operate this way: Ground station will transmit a carrier on the guard frequency. If the signal falls below a predetermined level, the guard receiver operates the diversity switch to unused antenna, holding to it even if signal gets stronger. Reason: to assure communication if the craft goes through unusual maneuvers.

A second unit consists of an automatic direction finder system and an auxiliary receiver. The auxiliary receiver ranges from 265.0-284.9 mc, with 20 crystal-controlled channels. For emergency back-up, the auxiliary adf receiver may be used for communications, and the receiving portion of the communications transceiver may be used for direction-finding. A transistorized control amplifier for antenna switching is part of the adf.

Another unit, a separate flush-mounted antenna assembly, contains radiating elements, antenna lobing switch, a-c drive motor, rate generator, synchro transmitter and associated gearing.

During test descents the X-15 pilot will use the adf to home on the terminal station. He'll land at Rogers Dry Lake near Edwards AFB, Calif., about 450 land miles from Wendover AFB, starting point for test.

MARCONI

TEST SETS FOR MOBILE RADIO

Designed for precision performance in

- ✱ *Receiver alignment*
- ✱ *Signal-to-noise measurement*
- ✱ *Discriminator testing*
- ✱ *Checking RF and audio outputs*
- ✱ *Deviation measurement*

. . . All you need for fast field testing of FM transmitters and receivers is here in these two complementary instruments, tailored for mobile radio measurements.

The 1064/2 provides high-grade FM outputs in the ranges 30 to 50, 118 to 185, and 450 to 470 mc; crystal-controlled i-f outputs at five spot frequencies; and a 1 kc AF output.

The 1065 has an RF power meter and 0-15 kc deviation indicator for use up to 500 mc; a dual-impedance AF power meter; and a multi-range volt/ammeter.

Each is lightweight, portable, and quality-engineered throughout. Tubes and crystals are all American types. Send for leaflet B117/A.

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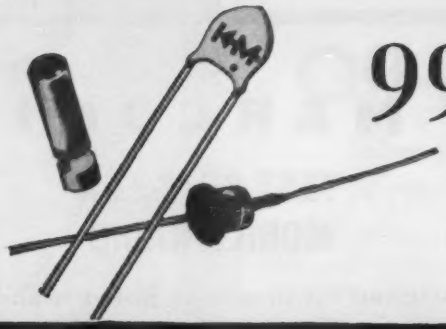


99.9999998%

CERAMIC CAPACITORS RIDE IN SATELLITES. Developed by Radio Materials Company, a Mallory Division, the ceramic capacitors shown here are mounted in the power supply circuit* of the Explorer IV satellite. They are part of an extensive line of ceramic types developed by RMC for commercial and military applications.
*Developed by State University of Iowa.

GROWING HIGH PURITY CRYSTALS FOR SILICON RECTIFIERS by unique "floating zone" technique results in rectifiers with exceptionally low forward drop and reverse leakage, and with highly uniform, long life.

PURE . . . . .

Research in Depth Makes the Difference

New Mallory Silicon Rectifiers Gain Extra Performance from New Research Concepts

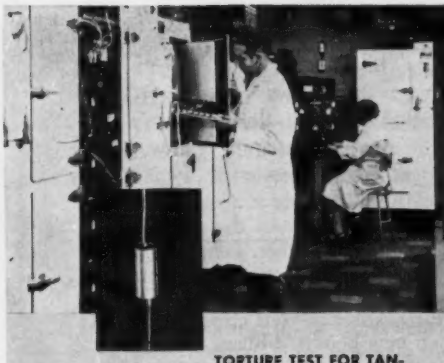
The source of the outstanding performance characteristics of the new line of Mallory silicon rectifiers is the same penetrating research which underlies all Mallory components. To produce a rectifier which would consistently do a superior job, solid-state physicists in the Mallory Corporate Laboratories developed a new approach to growing silicon crystals with purity far higher than previously possible. Using the Mallory-designed equipment shown here, crystals are manufactured by the "floating zone" method—with impurities of only *2 parts per billion*.

Parallel research at Mallory devised an improved way to form the diffused junction that gives the rectifier its one-way conducting quality. To protect the silicon element, specialists at Radio Materials Company, a Mallory Division, contributed "Mallo-Seal"*—an encapsulating compound exceptionally impervious to moisture. The result: a line of high-performance rectifiers at a price substantially lower than previously available units.

For your electronic equipment of today and tomorrow, you can look to Mallory for a constant stream of exciting products of research, coming from basic innovations in science from our Corporate Laboratories, and from the engineering ingenuity of our manufacturing divisions.

*Trade Mark

Research in Depth Makes the Difference in Mallory Components



TORTURE TEST FOR TANTALUM. Mallory tantalum capacitors, first types capable of 200°C. rating, are here going through one of many research and production tests to evaluate their ability to last thousands of hours under extreme environmental conditions. From the program has been developed a line of 12 different tantalum models, including the new Type TAS solid electrolyte unit shown here.

MANY NEW MALLORY PRODUCTS, especially those developed for operation in explosive atmospheres, at high altitude and high temperatures, require new concepts in hermetic sealing. On the mass spectrometer leak detector shown above, a new Mallory hermetically sealed switch case assembly, designed for a maximum leakage rate of 3 cc of helium in 10 years, is tested for terminal leaks. Inset shows a typical standard Mallory switch.

LOGGING LIFE OF MERCURY BATTERIES. Compact, powerful Mercury Batteries, a product of pioneering Mallory research, are tested for their ability to deliver constant power for extended periods under various climatic and circuit conditions. Latest product of Mallory research in Mercury Batteries is the new RM-312 cell shown here . . . only .305" in diameter and .135" high.

P R MALLORY & CO Inc.
MALLORY
P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

DAP

(ACTUAL SIZE)

DIFFUSED ALLOY POWER TRANSISTORS

Features

Faster Switching Times 0.5-5 μ Sec
Switching Currents up to 10 amperes
Flatter Frequency Response 40 Kc
Higher Breakdown Voltage up to 120 Volts
Current Gain of 40 at 5 amperes
Standard Power Transistor Package
Lower Base Resistance, 2 ohms
Lower Saturation Resistance, 0.1 ohm

Uses

TV Horizontal Output
Hi-Fi Amplifiers
Core Drivers
High Current Switching
Power Converters
Ultrasonic Generators
Modulators

Because no other transistor offers this combination of features and uses, you will want to try out the DAP transistor in your circuits. Get full details now on new Bendix diffused alloy power transistors by writing SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

	Ratings		Typical Performance			
	Vdc	Pc (25°C)	B (Ic=5 Adc)	Vs (Ic=5 Adc)	f_α	rbb'
2N1073	40	35 W	40	0.5 Vdc	1.5 mc	2 ohms
2N1073A	80	35 W	40	0.5 Vdc	1.5 mc	2 ohms
2N1073B	120	35 W	40	0.5 Vdc	1.5 mc	2 ohms

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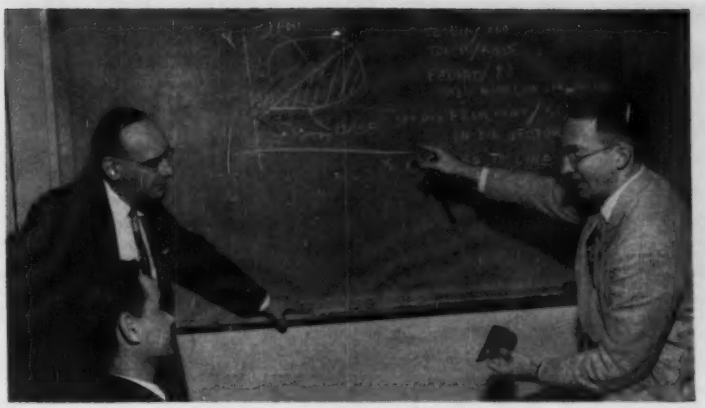
Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

Red Bank Division

Bendix AVIATION CORPORATION



Scientists at MIT discuss details of automatically programmed tool system

'Automatic Design' Nearer

MIT releases details on new automatic program for machine-tool control. Firms testing it

BOSTON—ERA of automatic parts design inched a step nearer this week with announcement at Massachusetts Institute of Technology of an automatic programming system for numerical control of machine tools.

The system, dubbed APT (automatically programmed tool) system, was announced jointly by MIT, USAF's Air Materiel Command and the Aircraft Industries Association. It allows the parts designer to program his machine tool without going through the tedious stickwork of manual coding, hitherto the principal bottleneck of numerical control systems.

APT makes use of a general-purpose computer to produce the tool-control tape. It accepts a plain-language description of the part's geometry, translates this into a taped machine-coded program which controls the machine tool.

Special Language

Key is English-like part-programming language developed at MIT Servomechanisms Lab under Air Force sponsorship. Computer, "understanding" special language, calculates all numerical data necessary for cuttings. It translates language into sequence of numerical instructions on tape.

More than 20 aircraft companies are cooperating in APT Joint Effort, organized in May 1957, with funds and technical information. Coordination has been taken over by Numerical Control Panel of AIA, enabling MIT, original coordinator, to do additional research. Advanced research is directed toward programming in terms of entire regions of surfaces in three dimensions. Current system can program three-dimensional space curves.

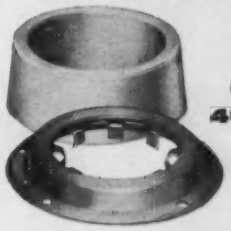
APT Joint Effort evolved from decision to pool computer programming manpower and resources to produce a complete system for industry-wide use. Further development of APT is open to all makers and users of numerical controls, not just in aircraft industry. APT language can produce control tapes for any of numerous machine tool systems.

APT is not the first automatic programming system for numerical control. But sponsors claim it has advantages of industry-wide compatibility and standardization and built-in expansion capabilities.

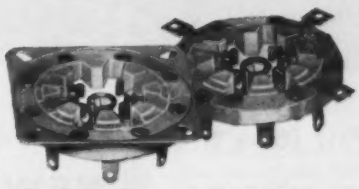
First industry-wide testing of APT started last April. Field tests, it was announced, have proved APT capable of performing "a real service for a limited but very useful class of parts."

LOW-LOSS KEL-F SOCKETS . . . for high-power transmitting tubes!

for tubes such as:



4X150A
4X150D
4X250B
4CX250B
7034
7035
4X250F



Designed for use with high-power transmitting tubes, these sockets are molded of low dielectric, loss-factor Kel-F plastic. Sockets are available in several designs—with or without screen grid by-pass capacitors. Control grid contact "guide" is machined for greater alignment accuracy—all contacts are low-resistance, silver-plated beryllium copper. Tube pin contacts are heat treated to provide positive contact pressure as well as extended life—annealed soldering tabs may be easily bent or formed. High quality, heat resistant, steatite chimney also available to direct air flow through tube cooling fins.

For details and complete specifications write for free catalog listed below:

New Catalog

Write today for your copy of our newest components catalog, complete specifications and prices!
• Capacitors • Knobs and Dials • Sockets • Inductors • Pilot Lights • Connectors • Insulators

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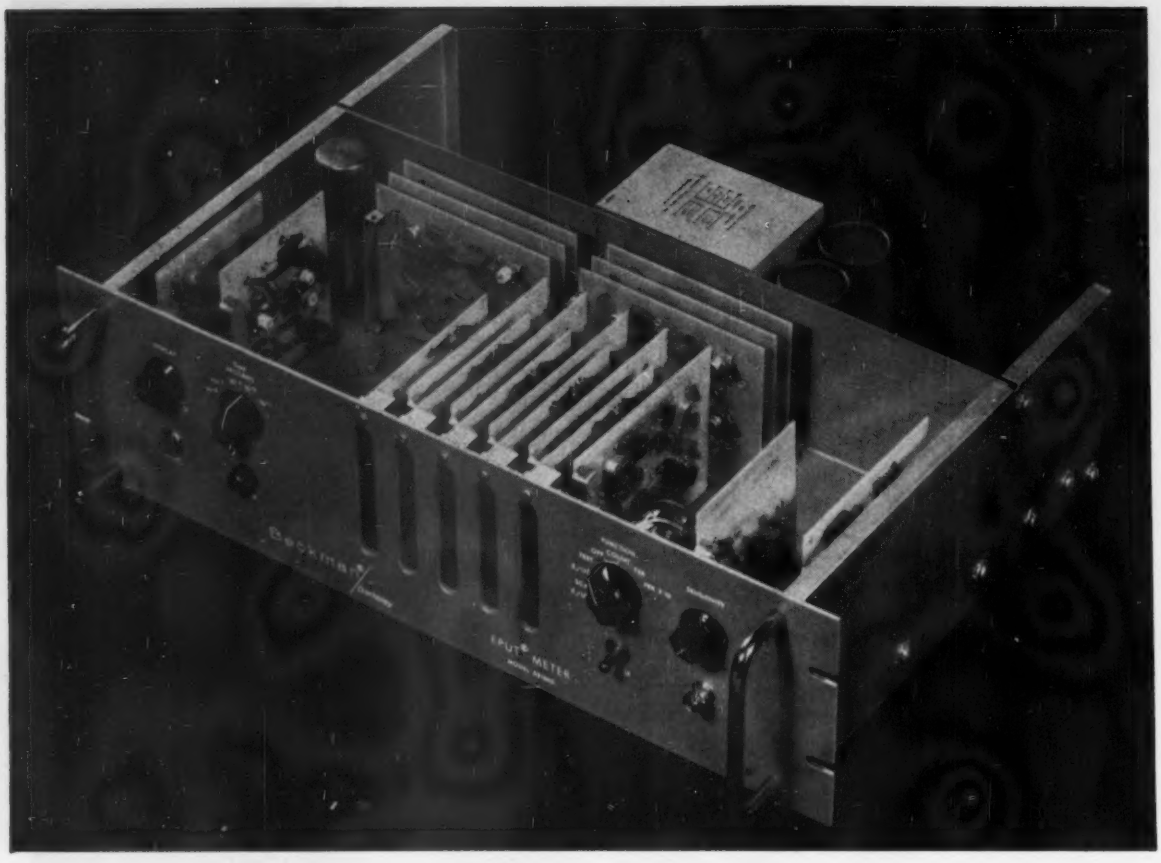
CIRCLE 36 READERS SERVICE CARD



For jobs that demand utmost dependability...

NEW SOLID-STATE FREQUENCY COUNTER

Frequency measuring range:	10cps to 200Kc
Counting intervals:	10 sec to 10 microsec in decade steps
Period measurements:	in units as small as 10 microsec
Input amplitude range:	100mv to 100v rms
Input impedance:	100K ohms
Accuracy:	up to 1 part in 10^5
Permissible ambient temperature:	–5°F to 150°F
Power consumption:	40 watts on 117-volt line
Panel dimensions:	5¼" high fitting a 19" rack
Weight:	20 lbs (25 lbs with cabinet)

Built exclusively of solid-state components, this new Beckman/Berkeley Eput® Meter exhibits dependable operation at temperatures from –5°F. to 150°F. under actual test – meets the most stringent requirements for both military and industrial use.

All circuits except the power supply are mounted on easily replaceable plug-in modules of only six different types. The time base is generated by digital circuits requiring no adjustment.

OTHER IMPORTANT FEATURES INCLUDE:

- *Adapted to systems use* by means of a 1-2-4-8 coded output supplied at a rear connector.
- *Accurate determination of low frequencies,* such as 60 or 400 cps, by making period measurements.
- *Compact, lightweight,* takes only 5¼" rack space.
- *Battery powered model* available for use where line power is not always handy.

Write for technical Bulletin 5310.

See it at IRE · BOOTHS 3416 and 3418

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TD-3

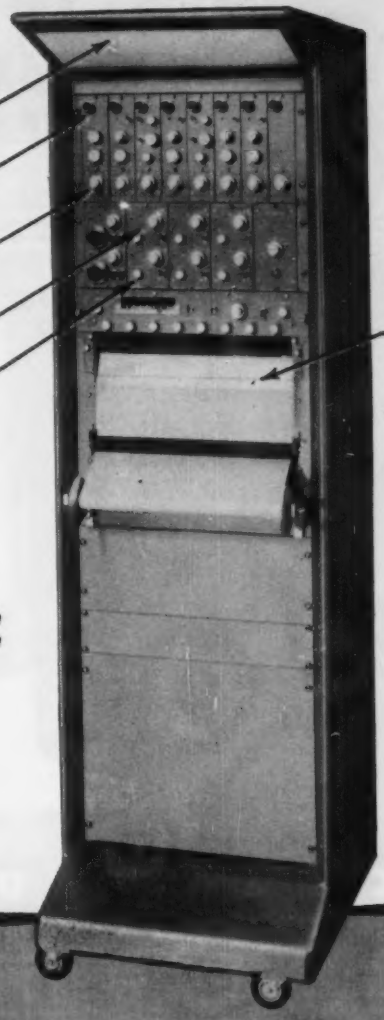
CIRCLE 37 READERS SERVICE CARD

CIRCLE 38 READERS SERVICE CARD→

OFFNER
ALL TRANSISTOR

TYPE R DYNOGRAPH

the most versatile . . . most sensitive direct writing unit available



Illuminated canopy

Type 9800 series input couplers provide all input, control and balance functions. Input available both front and rear.

Type 481 Preamplifier provides sensitivities from one microvolt to 5 volts per mm.

Type 482 power amplifiers—may be used without preamplifiers for up to 10 mv/cm sensitivity

Zero suppression control

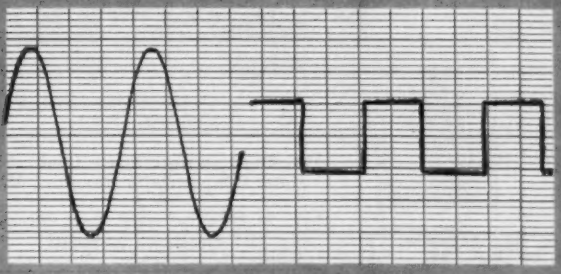
504-A paper drive—speeds from 1 to 250 mm/sec. Electrical speed shift 1 to 250 mm per minute available. Zero weave high precision drive, 850 ft. capacity (heat or electric) 1500 ft. (ink). Front loading, with full unobstructed record visible from front.

Combining all these features...

- *stable d-c sensitivity of one microvolt per mm*
- *true differential input*
- *high input impedance*
- *response to beyond 150 cps.*
- *reluctance, differential transformer, strain gage with a-c or d-c excitation, thermocouples, etc., used with all preamplifiers*
- *deflection time less than 1.5 milliseconds (2.5 ms with preamplifiers)*
- *fixed precision calibration*
- *instant warm-up*
- *precision source for d-c and 400 cycle excitation, self-contained*
- *zero suppression, twenty times full scale, both directions*

Thanks for your patience in awaiting deliveries of the Type R. Schedules were temporarily disrupted by the large volume of orders received for this radically new instrument. We are now in our new plant, with 300% more space, and are rapidly increasing production capacity. Deliveries will soon be on a current basis.

FULL SCALE, UNRETOUCHED CHARTS PRODUCED ON THE TYPE R DYNOGRAPH



EXTREME SENSITIVITY

10 Microvolt RMS Sine Wave — **Ten Microvolt D-C Square Wave**

Four recording media. Heat or electric rectilinear—ink or electric curvilinear. Readily convertible.

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MEETINGS AHEAD

Mar. 3-5: Western Joint Computer Conf., AIEE, ACM, IRE, Fairmont Hotel, San Francisco.

Mar. 5-7: Western Space Age Conf. and Exhibit, L. A. Chamber of Commerce, Great Western Exhibit Center, Los Angeles.

Mar. 15-18: National Assoc. of Broadcasters, Annual Convention, Conrad Hilton Hotel, Chicago.

Mar. 23-25: Flight Testing Conf., ARS, Daytona Beach, Fla.

Mar. 23-26: Institute of Radio Engineers, IRE National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Mar. 24-25: Institute of Printed Circuits, Annual Meeting, N.Y.C.

Mar. 31-Apr. 2: Millimeter Waves Symposium, Polytechnic Inst. of Brooklyn, USAF, ONR, IRE, USA Signal Research, Engineering Societies Bldg., N.Y.C.

Apr. 5-10: Nuclear Congress, sponsored by over 25 major engineering and scientific societies, Public Auditorium, Cleveland.

Apr. 6-7: Astronautics Symposium, Air Force Office of Scientific Research, Sheraton-Park Hotel, Washington, D. C.

Apr. 13-15: Protective Relay Conf., A & M College of Texas, College Station, Tex.

Apr. 14-15: Industrial Instrumentation & Control Conf., PGIE of IRE, Armour Research Foundation, Illinois Inst. of Tech., Chicago.

Apr. 16-18: Southwestern IRE Conf. and Electronics Show, SWIRECO, Dallas Memorial Aud. & Baker Hotel, Dallas.

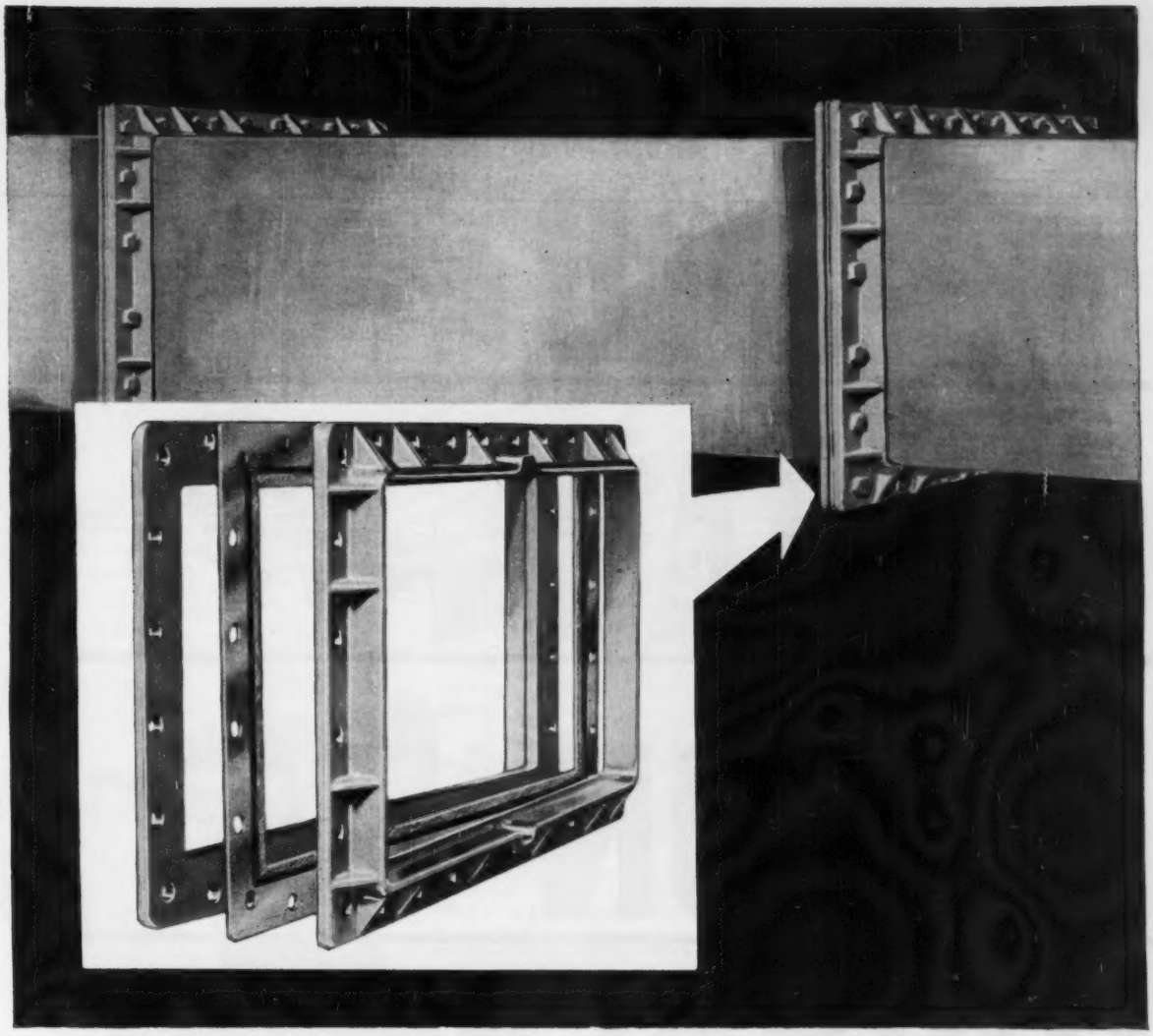
Apr. 20-21: Analog & Digital Recording & Controlling Instrumentation, AIEE, PGIE & PGI of IRE, Bellevue-Stratford Hotel, Philadelphia.

Apr. 20-22: Instrument Society of America, Southeastern Conf. & Exhibit, Gatlinburg, Tenn.

Apr. 20-22: Man-in-Space Conf., ARS, Hotel Chamberlain, Hampton, Va.

Apr. 21-22: Electronic Data Processing, IRE Section, Cincinnati.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 88.



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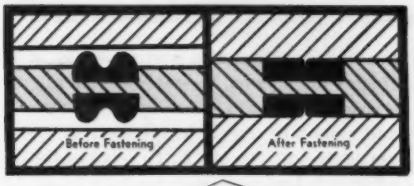

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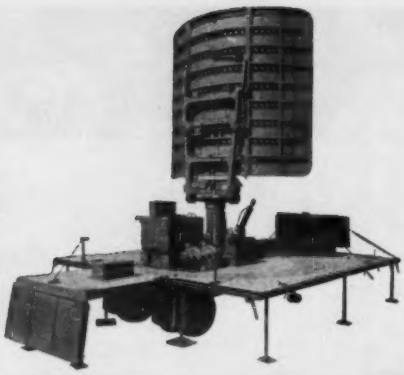

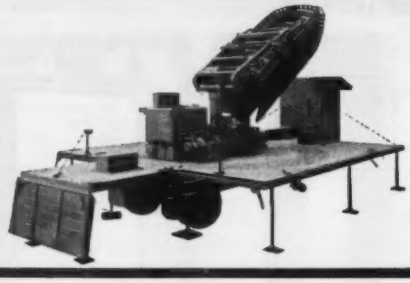

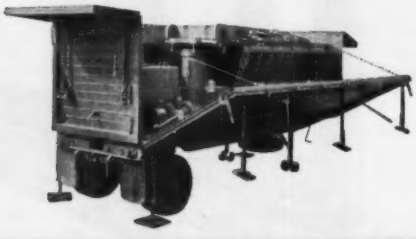

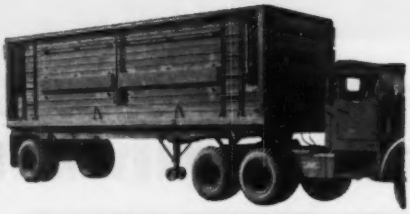

How to conceive a radically improved radar scanning technique. How to integrate this technique into a superior data handling system. How to make the complete scanning and data handling system mobile.

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And then they made this complete radar and data handling system mobile. The radar scanning antennas (shown above) can be converted for travel on the road in minutes. The complete data processing and radar scanning systems, with all of their wide capabilities, have been engineered to occupy only a few standard size army van trucks.

The research, development and production of this advanced system is typical of the creative engineering now underway at Hughes in Fullerton. If creative engineering is your forte, you will find abundant aesthetic and monetary reward at Hughes. To investigate write to Mr. L. P. Wike at the address below.

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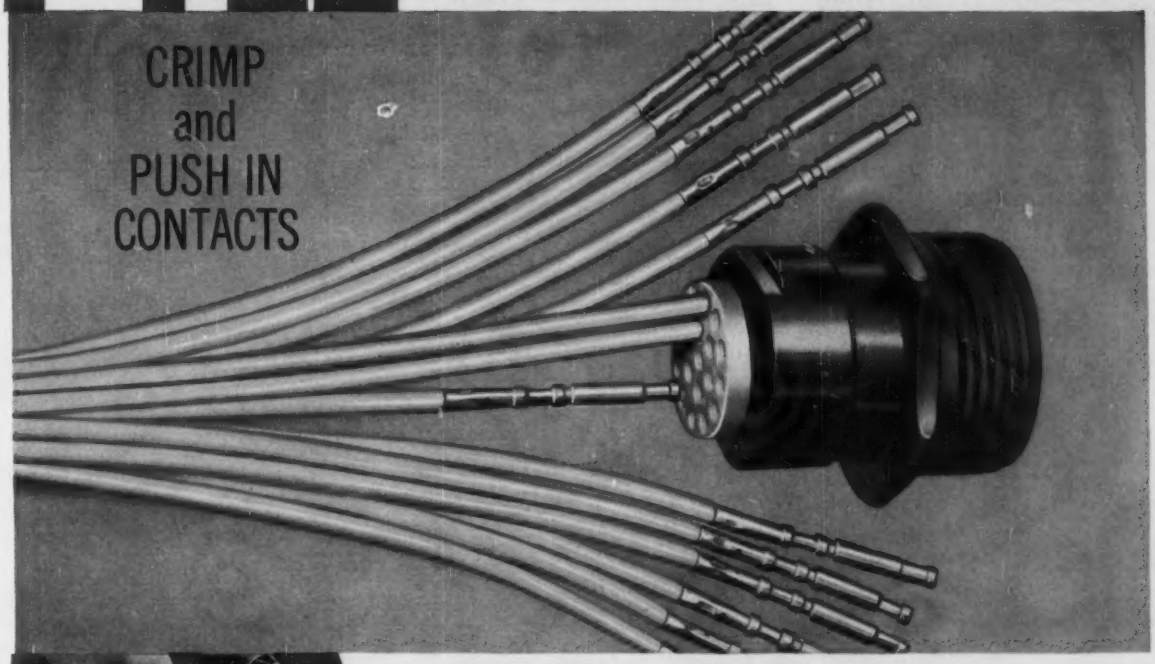

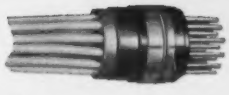

Mod. 2 Insert, 19-Pole
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1. Individual contacts are crimped to wires outside connector by a semi-automatic tool, then, for assembly, inserted one by one into insulation with crimped joint intact.

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6. *Two-piece Mod. 2 insert* is interchangeable within Standard Pyle-Star-Line barrel shells with *three-piece Mod. 1 insert.*

Mod. 1 inserts for wire sizes up to 4/0 are available for disconnect and for current rupturing service.

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Chemical Resistance	Most acids, most alkalis, oil
Corrosion Resistance	Salt Spray: 300 days without failure
Dust Resistance	Exceed requirements of MIL C-5015D
Shock Resistance	50G Minimum
Vibration	Exceed 20G to Method II of Mil C-5015D
Humidity & Moisture Resistance	Exceed Class E. Spec. of Mil C-5015D
Air Leakage	Meet Class E Spec. of Mil C-5015D

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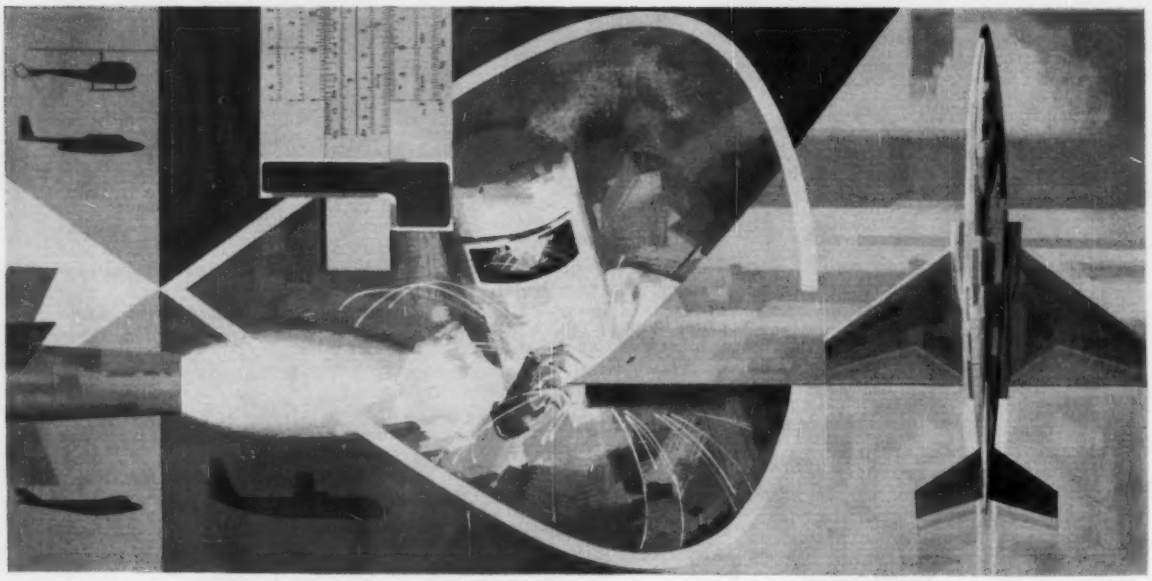

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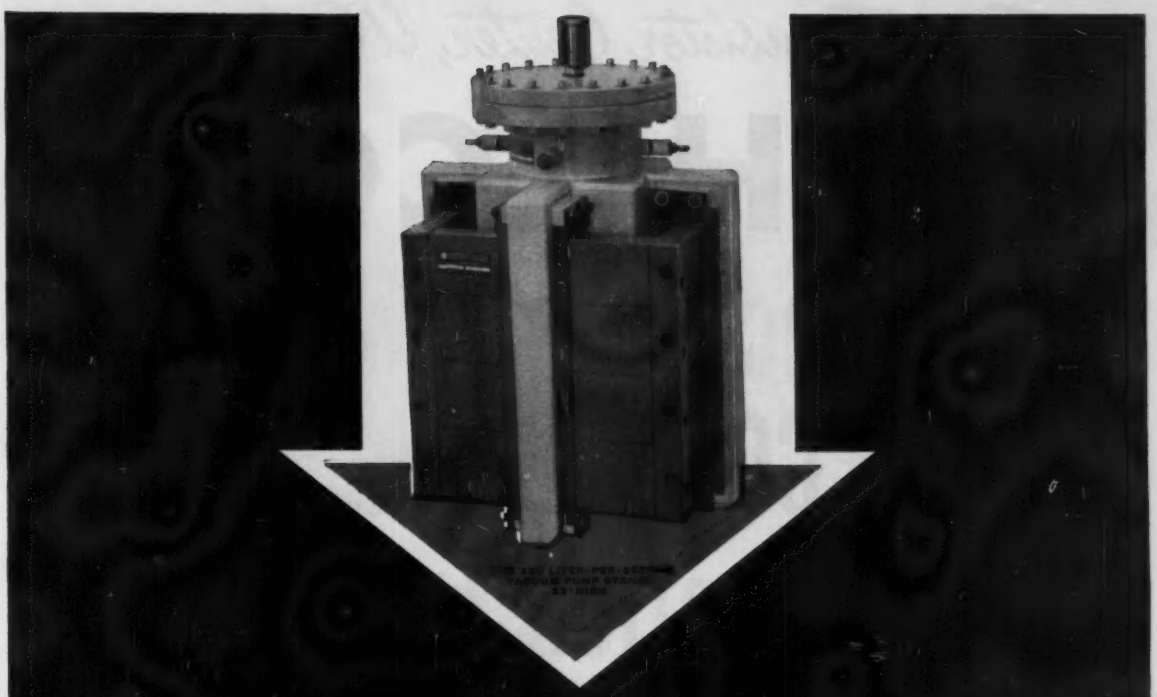

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	TYPE	V_{CB} Max. (Volts)	V_{CES} Max. (Volts)	Peak I_C (Amps)	P Max. (Watts)	$F_{\alpha b}$ (MC)	Beta	Applications	PRICE
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	2N1125	40	40	0.5	0.3	1.0 Min	h_{fe} 50-150 @ 0.5 amp	For high voltage, higher frequency industrial amplifier and switching systems. Large signal beta controlled.	$1.90
	2N1126	40	35	0.5	1.0	0.4 Min	h_{fe} 40 Min	1 watt version of 2N1124 for servo amplifiers and relay actuators. Small signal beta controlled.	$1.80
	2N1127	40	40	0.5	1.0	1.0 Min	h_{FE} 50-150 @ 0.5 amp	1 watt version of 2N1125 for servo amplifiers and control systems. DC beta controlled.	$2.40
	2N1128	25	18	0.5	0.15	1.0	h_{fe} 70-150	For low distortion, high level driver and output application. Small signal beta controlled.	$ .95
	2N1129	25	25	0.5	0.15	0.75	h_{FE} 100-200 @ 0.1 amp	For high gain general purpose amplifier and switching. Typical DC beta 165.	$1.10
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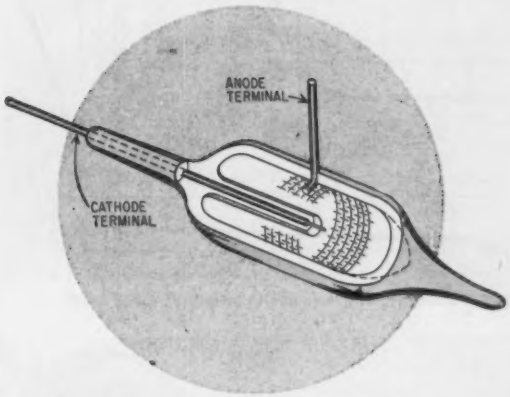


FIG. 1—View shows construction of typical solion diode

In production, automatic recording equipment tests and calibrates solion integrator units

Current Integration With Solion Liquid Diodes

Complementing transistors and vacuum tubes in control applications, the solion shows promise as a useful and versatile device. Units for integrating fluid pressures, flows and electrical currents are described

By R. N. LANE, Texas Research Associates, Austin, Texas, and
D. B. CAMERON, National Carbon Co., Division of Union Carbide Corp., New York, N. Y.

AS CONTROL ELEMENTS, solions have special advantages over transistors and vacuum tubes at low frequencies because they permit reduction of power requirements, simplification of circuits and increased reliability and ruggedness. In many low-frequency applications, a single solion may replace a complete circuit assembly.

Electrochemical diodes can be produced in many configurations, one of which is shown in Fig. 1. A common design employs anodes and cathodes of equal area. A typical polarization characteristic for such a diode is essentially the same for either polarity. Diodes such as in Fig. 1 in which the anode and cathode areas differ greatly exhibit the familiar rectifier characteristic shown in Fig. 2.

Forward to reverse current ratios of 500 to 1 are obtainable. The reverse current characteristic is temperature sensitive and in a typical unit is about 1.5 percent current change per deg F. Maximum reverse voltage is 0.9 v for long unit life. It may be noted that operation of solions below 0.1 v for extremely low-frequency applications is superior to that of the best semiconductor diodes. Furthermore, solions can be made quite insensitive to vibration.

VISUAL READOUT INTEGRATOR—The solion

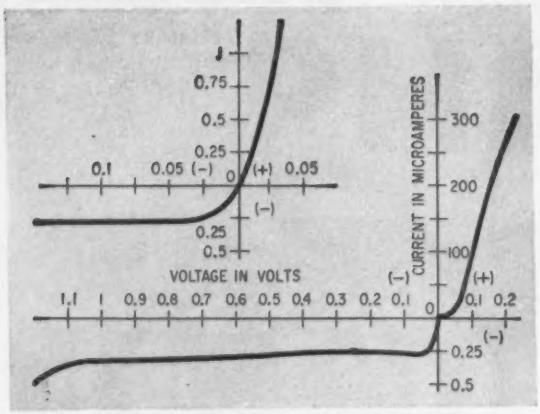
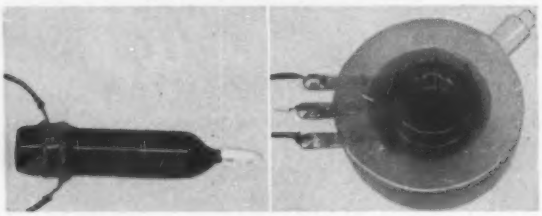


FIG. 2—Forward and reverse characteristics of solion diode



Typical solion units. At left is a visual readout integrator; at right, a linear detector

integrator takes advantage of the fact that local concentration of iodine is changed by electrochemical reaction as current passes through the diode system. Figure 3 is a sketch of a visual readout integrator. It consists of two separate electrolyte chambers of different volume. A platinum electrode is located in each chamber and the two chambers are separated by a diffusion barrier such as a porous fritted disk or simply a small capillary tube. The diffusion barrier prevents mixing of the electrolyte in the two compartments by diffusion and convection while also maintaining a conductive path of electrolyte between the compartments. The usual electrolyte employed is an iodine-potassium iodide solution.

When current passes between the electrodes, iodine is reduced to iodide at the cathode and iodide is oxidized to iodine at the anode. The concentration of iodine in the two compartments is thus changed by the current flow in accordance with Faraday's law. Measurement of the iodine concentration provides an exact value of the number of coulombs flowing between the electrodes.

Iodine concentration can be determined visually or electrically. An aqueous solution of potassium iodide is a clear, colorless liquid, while the iodine solution has the familiar brown color. A change in iodine concentration in either compartment produces a color change in the solution. By visual comparison with a color chart, it is possible to determine the integrated value of the current which has flowed. Probable error of visual determination is about ten per cent. For many applications this simple visual readout is sufficiently accurate.

CONCENTRATION VOLTAGE—If greater accuracy is required, the degree of integration of the visual readout integrator can be measured with an electrometer. A difference in the concentration of iodine in the two chambers of the integrator results in a concentration voltage developing between the two electrodes. Depending on the concentration difference, this voltage will be as much as 50 to 100 mv.

Since the solion employs a reversible process, the integrator can be cleared or reset by reversing the direction of current flow between the two electrodes.

An example of an application of the visual readout integrator is an integrating sound exposure meter or noise dosimeter. A circuit for such a device is shown in Fig. 4. It consists of a microphone, two-stage transistor amplifier and a rectifying diode feeding a visual readout solion integrator. This device can be worn by a person exposed to dangerously high levels of noise. Any degree of sensitivity can be obtained by adjusting the amplifier gain. The device can be made frequency-sensitive or it can be modified to integrate noise levels above some predetermined background level.

ELECTRICAL READOUT INTEGRATOR—It is possible to design an electrical readout integrator in which a sensitive electrometer is not required. The integral may be read continuously while integration is taking place without affecting its value, and the equilibrium time of the integral is less than one second.

If a pair of auxiliary electrodes are placed in the integral chamber, they have the characteristics of a solion diode. Since the saturation current is controlled by iodine concentration in the electrolyte, if the auxiliary electrodes are supplied with voltage from a separate battery and a microammeter is placed in the circuit, deflection of the microammeter is a measure of iodine concentration in the integral chamber. The meter can be calibrated directly in microcoulombs.

Solion integrators are sensitive to temperature changes. A temperature change affects the electrical resistance of the integrator and the diffusion rate of the iodine in the integral chamber. The

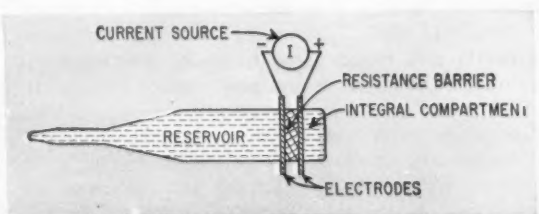


FIG. 3—Solion designed as a visual readout integrator

resistance change usually can be made insignificant by deriving the input from a high impedance source. In Fig. 5A, the integrator readout is compensated with varistors.

TYPICAL APPLICATIONS—The electrical readout integrator lends itself to use in the design of a simple, accurate linear time base. The readout current increases linearly with time for constant current input, and can therefore be used as the input to the axes of an X-Y recorder.

Figure 5B shows the diagram of a time-base circuit. Readout current is temperature compensated by negative temperature coefficient resistor R_T. Resistor R_M represents the input resistance of the current range of the X-Y recorder and must be considered in calculating the value of R_T. Linear time bases as long as one hour for full scale can be obtained using this circuit.

An electrical readout integrator can also be used as an amplifier to obtain power gain; however, it is not an amplifier in the sense that it faithfully reproduces the input signal. For a sine wave input a sine wave output is obtained with a phase shift of 90 deg. For a square wave input, a triangular wave output is obtained. Since it is an integrator, the amplitude of the output varies as $1/f$, where f is the input signal frequency. The amplifier can be made to reproduce the input with a flat frequency response from 0.1 cps to about 2 cycles/hr by placing a capacitance of about 320 μf in series with the input.

The power gain of this integrator used as an amplifier for a sine-wave input of 0.01 cps is 27 db. The upper frequency limit of the present amplifiers is about 0.5 cps.

LINEAR DETECTORS—It is possible to use the same principle in the design of a flow or pressure detector. A solion linear detector consists of two electrolyte chambers separated by a small orifice as shown in Fig. 6. For linear response this orifice is usually a narrow slit. The detector cathode is located inside the orifice. A battery causes iodine to be reduced at the separator cathode and iodide is oxidized to iodine at the anode. This results in a concentrated iodine solution in the anode chamber and a dilute iodine solution in the separator chamber. Iodine in the orifice is reduced to iodide at the detector cathode. Lack of iodine at the cathode then causes the current indicated by the microammeter to drop to an extremely low value. This can be as low as 10 μa. This background current results from diffusion of a small amount of iodine from the concentrated solution into the orifice.

If the diaphragm on the concentrated side is deflected, iodine is forced through the orifice, producing a reaction at the cathode and causing an increase in current.

For a detector operating linearly, the current output is given by the equation $I = FN\ dV/dt \times 10^{-6}$, where F is the Faraday, N is the normality of the reducible substance on the anode side, and dV/dt is the flow rate in cu cm/sec. If the iodine normality is 0.1, flow rates as low as 10^{-5} cm^3/sec yield currents in the neighborhood of 100 μa, or approximately 10 times the background current. With suitable design of the detecting cathode, linear outputs can be obtained over a range of four orders of magnitude in flow rates.

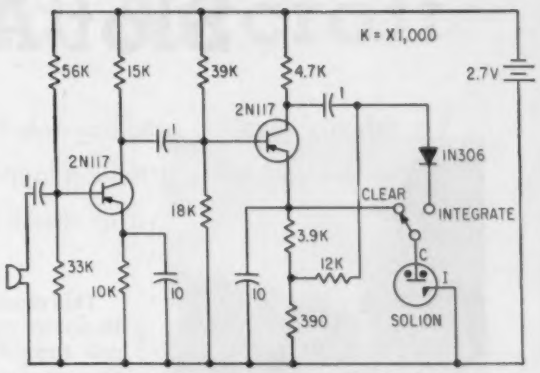


FIG. 4—Schematic diagram of a transistorized noise dosimeter using a solion for visual readout integration

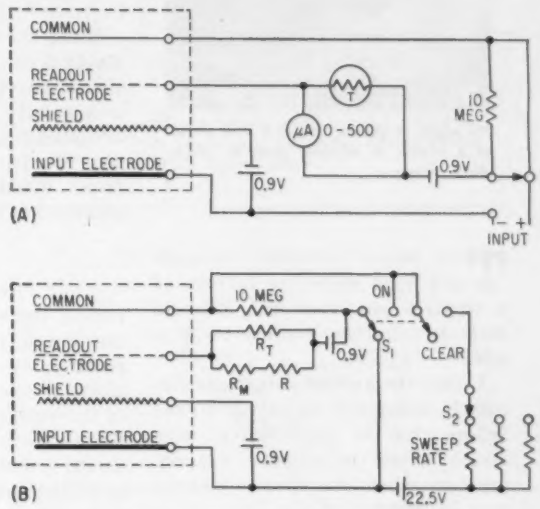


FIG. 5—Electrical readout integrator circuits. (A) is thermistor-compensated meter circuit and (B) time base for X-Y recorder

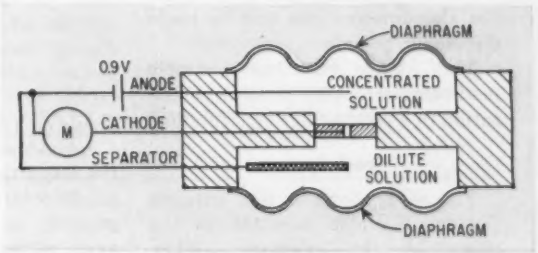


FIG. 6—Solion linear detector. Device can be used for pressure or flow transducer

Slot-Antenna Array

By E. J. WILKINSON,

Sylvania Electric Products Inc., Waltham, Mass.

Tilt angle of dipole, installed in a model of a missile, is adjusted prior to taking plane patterns

THE BROAD PATTERN coverage and flush mounting feature of a linearly polarized slot antenna make it attractive for use on missiles.

Unless the ground antenna is circularly polarized, however, signal fading due to polarization mismatch often becomes a serious problem when the missile maneuvers in flight.

A circularly polarized ground antenna, on the other hand, implies a 3 db loss in maximum gain unless the slot antenna can also be made circularly polarized.

This article describes a simple method of achieving circular polarization in a rectangular slot antenna.

Feed System

Figure 1 shows a slot antenna fed by a dipole mounted in the plane of the aperture. When oriented horizontally, the dipole has no resultant field component transverse to the slot, and does not excite it.

However, a horizontally polarized wave is radiated that has a 3-db pattern coverage of about 90 deg by 60 deg. These patterns change little when the dipole is tilted slightly, but now a transverse field component excites the slot.

This component is approximately in phase quadrature with the dipole current over the region near the center of the slot hence induces a slot aperture field which is also in phase quadrature with the dipole current.

Since the center of phase of the dipole is coincident with that of the slot, approximate circular polarization results when the tilt angle is adjusted for dipole and slot radiation of equal magnitude, radiation from dipole being orthogonally polarized to that of the slot.

Tuning

Exact circularity is achieved by tuning the slot, that is, adjusting the depth of the short-circuited rectangular waveguide section behind the aperture. Thus the phase of the vertically polarized wave reflected back to the aperture is varied. The resultant vertically polarized radiation is brought into exact phase quadrature with the horizontally polarized radiation. This compensates for two things: first, the small vertically polarized component radiated by the tilted dipole, second the lack of exact phase quadrature between the exitation field of the dipole and the dipole current.

Adjustment of depth also varies the magnitude of the resultant vertically polarized radiation. But this presents no problem since the tilt angle of the dipole varies the magnitude approximately independent of the phase when the conditions for circular polarization are approached.

Radiation Pattern

The principal plane patterns of a dipole-excited slot are shown in Figs. 2 and 3. Axial ratios are of the order of 1 or 2 db over ± 45 deg of the pattern maximum. The symmetry of the patterns for the various components indicate that the orientation of the polarization ellipse remains fixed. The beamwidth for good circularity is limited primarily by the width of the dipole pattern in the plane transverse to the slot.

Figures 4 and 5 show the coverage of the circularly polarized slot when mounted in a missile. Figure 6 is a sketch of the missile configuration used for taking these patterns.

The above radiation characteristics can be maintained over about a 20-percent bandwidth. Matching to a 50-ohm line over the same 20-percent band is accomplished as follows: The dipole is folded. This action raises its radiation resistance which was initially quite low due to the proximity of the metal ground plane and slot; the length of the dipole is adjusted; and the length of the short circuited split cylinder line used to support the dipole is adjusted . Figure 7 is a sketch of the folded dipole probe assembly. The resultant impedance characteristic is shown in Fig. 8. The vswr is less than 1.8 over the band.

Polarized Slot

The circularly polarized slot is also suitable for use as an element in an electronically scanned array. Decoupling between terminals of adjacent circularly polarized slots as a function of center-to-center spacing in wavelengths is shown in Fig. 9. Compared to other types of elements the decoupling is relatively high, especially for spacings under a half wavelength. This is important since close spacings are required for wide-angle scanning and interaction between sources connected to the terminals of the elements should be kept small.

for Missiles and Aircraft

Simple modification of a linearly polarized slot radiator achieves circular polarity for antenna array used on missile. Signal mismatch, caused by motion of missile in flight is minimized, making ideal missile array

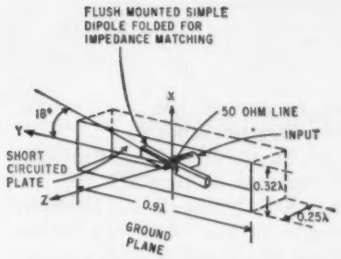


FIG. 1—Slot antenna fed by a dipole mounted in the plane of the aperture. Angular orientation is adjustable

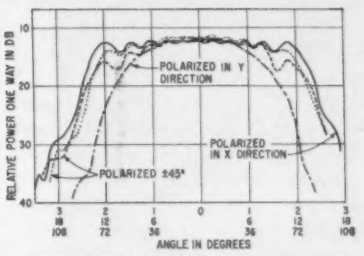


FIG. 2—Relative one-way power in db is plotted against angle. Patterns are taken in the plane of missile axis

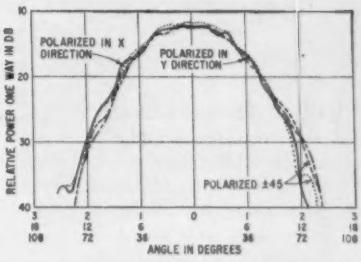


FIG. 3—Patterns taken in plane transverse to missile axis. Plot shows relative power in db against angle

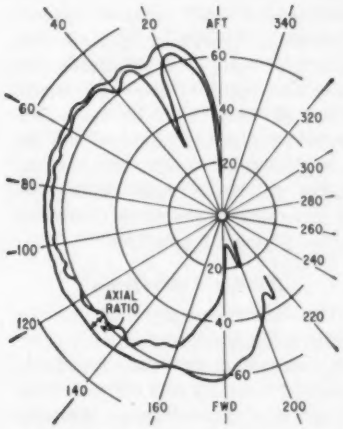


FIG. 4—Smith chart plots show maximum and minimum coverage of circularly polarized slot taken in plane of missile axis

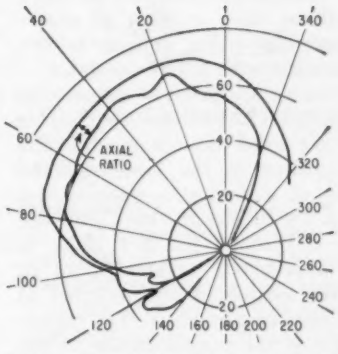


FIG. 5—Plots show maximum and minimum coverage of circularly polarized slot taken in plane transverse to missile axis

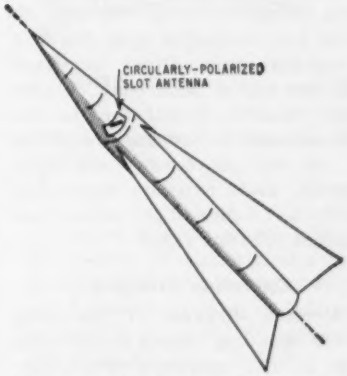


FIG. 6—Sketch of missile configuration shows location of slot antennas used to obtain circular polarization

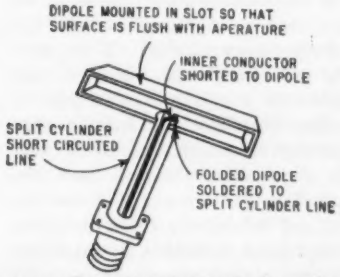

DIPOLE MOUNTED IN SLOT SO THAT SURFACE IS FLUSH WITH APERATURE
INNER CONDUCTOR SHORTED TO DIPOLE
SPLIT CYLINDER SHORT CIRCUITED LINE
FOLDED DIPOLE SOLDERED TO SPLIT CYLINDER LINE

FIG. 7—Sketch of folded dipole slot probe assembly for circular polarization

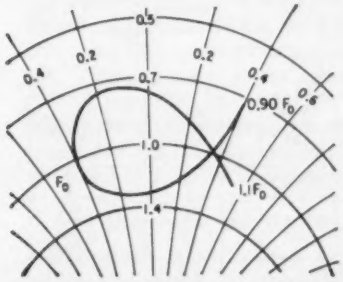


FIG. 8—Smith chart plot of input impedance against frequency

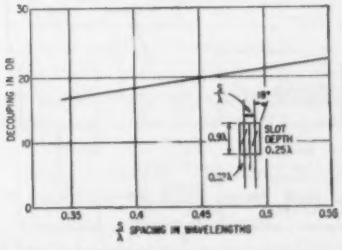


FIG. 9—Plot of decoupling against spacing in wavelengths

Carcinotron Harmonics

Superheterodyne receiver affords continuous frequency coverage from 30 mc to greater than 75 kmc by application of harmonic mixing. Carcinotron that is voltage-tunable from 2 to 4 kmc serves as local oscillator for two separate r-f systems, providing exceptionally broad tuning range.

USE OF ANTENNA SCALE modeling techniques and the development of wide-frequency antenna pattern ranges have created the need for sensitive wide-frequency range receiving systems for antenna pattern measurements.

The superheterodyne receiver to be described features continuous frequency coverage from 30 mc to greater than 75 kmc without the use of plug-in units. Sensitivities better than 30 db greater than the conventional crystal-video detection system or from −70 to −90 dbm are attainable over the full frequency range. Other important features provide square-law (bolometer) detector output for the antenna pattern recorder, reception of c-w or square-wave modulated signals, 40-db dynamic range, linearity to 1.0 db and afc action over the full dynamic range.

Operating Principle

A block diagram of the wide range receiving system is shown in Fig. 1. The extremely broad tuning range of the receiver is obtained by the use of two separate r-f systems. The tunable local oscillator, used with both r-f systems, is a type QK518 or QK691 backward-wave oscillator or Carcinotron. This tube is voltage tunable over a frequency range of from 2 to 4 kmc with a minimum power output of 250 mw.

A 1-kc modulation component is added to a received c-w signal sweeping the Carcinotron voltage-tunable delay line with a 1-kc sawtooth voltage of sufficient amplitude to frequency modulate the local oscillator over a range of several megacycles. This voltage is synchronized with a 1-kc oscillator.

During operation of the receiver from 2 to 75 kmc, the Carcinotron output is fed through an adjustable attenuator to the local oscillator arm of a frequency-selective tee. This tee couples the local oscillator signal through RG-55/U cable to an appropriate crystal mount or mixer located at the terminal of the receiving antenna. The capacitance of the crystal holder on the crystal mount is reduced to a minimum to provide low vswr on the coaxial transmission line.

The Carcinotron delay line voltage required to tune the receiver to a specific frequency can be determined to within ±5 percent by referring to a receiver tuning chart. The delay line voltage is metered for the purpose of tuning. The Carcinotron is tuned to obtain a 65 mc difference signal between the local oscillator fundamental or harmonic and the received signal. Normally, reception can be obtained at two local oscillator frequencies spaced 130 mc apart, either of which may be used. The 65-mc i-f signal is coupled by the coaxial cable from the crystal mount to the frequency-selective tee through which it is channeled to the 65-mc i-f amplifier.

Double Conversion

The low-frequency r-f system employs double conversion to permit reception in the frequency range of from 30 to 2,000 mc while using the Carcinotron as the tunable local oscillator. A low-frequency antenna is coupled through a 50-ohm coaxial cable to the first mixer. The Carcinotron output is fed through the variable attenuator into the local oscillator input of the first mixer. A signal in the frequency range of from 30 mc to 2 kmc reaching the first mixer is converted to a 2.1-kmc i-f signal by tuning the bwo 2.1 kmc higher. The high-Q cavity, located between the first mixer output and the second mixer input, provides the first i-f selectivity. The 2,035-mc second local oscillator signal is fed into the second mixer and converts the first i-f signal into a 65-mc

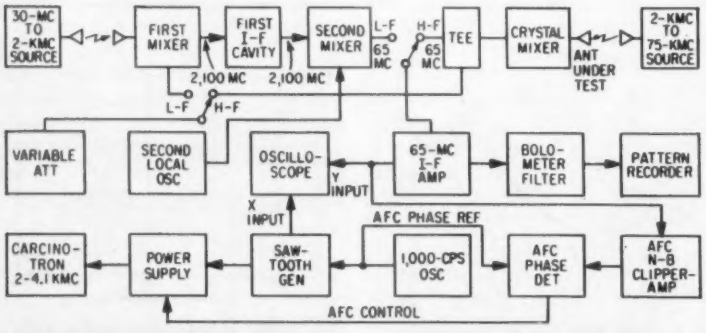
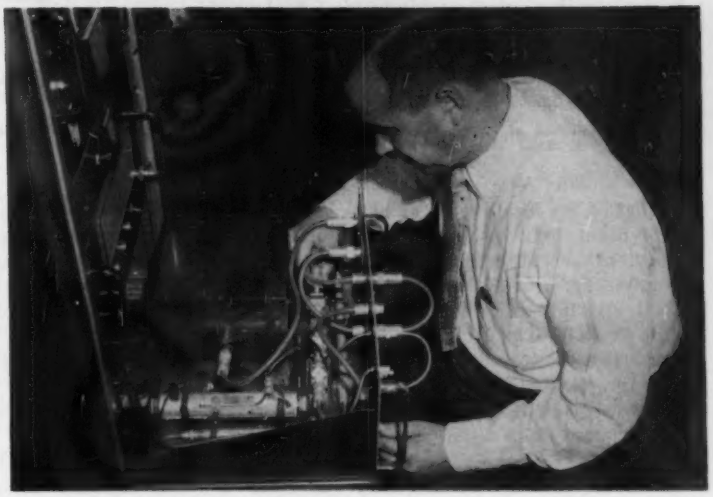


FIG. 1—Wide-range receiving system applied to antenna pattern recorder system

Boost Receiver Range

By C. H. CURRIE,
Chief Electronics Engineer,
Scientific-Atlanta, Inc.,
Atlanta, Georgia



Local oscillator of wide-band receiver is backward-wave oscillator (Carcinotron) shown in r-f unit of antenna pattern measurement system

second i-f which enters the i-f amplifier.

This circuit is a synchronous single-tuned amplifier with a half-power bandwidth of 1 mc. Frequency modulation of the Carcinotron output, provided by a sawtooth voltage applied to the delay line, causes an i-f signal, developed from a c-w receiver input signal, to be swept across the pass-band of the i-f amplifier. This action results in an i-f amplifier signal output with an envelope representing the band-pass characteristics of the i-f amplifier. The amplifier characteristic is shaped so that the output signal envelope displayed on the monitor oscilloscope has the general appearance of a half-loop sine wave.

Video Outputs

Two separate i-f amplifier video outputs are provided. The first, a linear output derived from a crystal detector, is fed to the vertical deflection amplifier of the monitor oscilloscope and to the afc amplifier. The second is derived from a square-law bolometer detector and is coupled through a 1-kc band-pass filter to the output connector for the antenna pattern recorder.

The receiver includes an afc system which compares the phase of the 1-kc i-f amplifier output envelope with that of the sweep voltage applied to the Carcinotron delay line. The afc phase detector develops an error voltage proportional to the magnitude and direction of displacement of the crest of the i-f amplifier output waveform with respect to the center of the sawtooth sweep voltage. This error voltage controls the Carcinotron delay line voltage so as to oppose a phase displacement. This results in an automatic shift of the Carcinotron frequency to compensate for a change in the received signal frequency. By the use of a narrow-band limiting afc amplifier, stable afc operation is obtained over a dynamic signal range of 45 db or more.

When receiving a square-wave modulated signal, the transmitted signal modulation is adjusted to a frequency of approximately 900 cps. This assures that the antenna pattern recorder pen will not respond to the beat frequency between the square-wave modulation and the 1-kc internal oscillator.

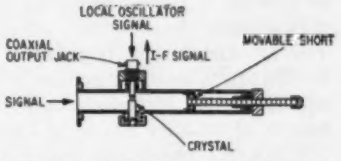


FIG. 2—Crystal holder used for harmonic mixing

FIG. 3—Cross-section of frequency-selective tee

Harmonic Mixing

Frequency multiplication to the microwave region is often accomplished by harmonic generation in a silicon crystal.

A more efficient means of using the crystal harmonic generator in a superheterodyne receiving system is harmonic mixing. Harmonic mixing is a method of generating the harmonic local oscillator signal and mixing in the same crystal.

A microwave crystal holder which may be used for this purpose is shown in Fig. 2. The fundamental local oscillator signal is introduced through the coaxial output jack and is applied across the crystal. With sufficient applied power, the non-linear crystal characteristic results in a local oscillator signal across the crystal which is rich in harmonics. Mixing takes place by the application of the signal to this same crystal and by adjusting the local oscillator fundamental frequency for the proper harmonic relationship to provide the required i-f sum or difference frequency.

Since the frequency of the signal

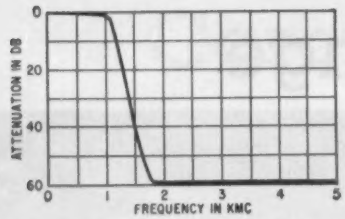


FIG. 4—Attenuation of low-pass filter

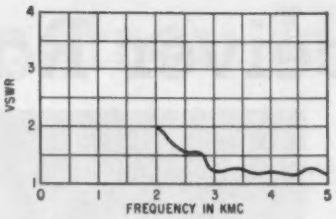


FIG. 5—Vswr of frequency-selective tee

and that of the local oscillator harmonic differ only by the i-f frequency, proper adjustment of the movable short provides a maximum of both signal and harmonic power at the crystal. The i-f signal appears across the coaxial output jack and is propagated down the same cable which couples the local oscillator fundamental signal to the crystal.

Harmonic mixing considerably reduces the fundamental local oscillator power that must be furnished to the crystal as compared to the method using a conventional mixer. The problems of harmonic transmission and isolation of the harmonic generator from the mixer do not arise with harmonic mixing.

Oscillator Power

To permit harmonic mixing for the reception of signal frequencies above 4 kmc, it is necessary to supply more local oscillator power to the crystal mixer than would normally be required for fundamental operation. Since this local oscillator signal is supplied to the mixer through a section of coaxial cable varying in length from 15 to 75 feet, power loss in this cable must be overcome. The power output of the QK518 oscillator is sufficient for this purpose.

The crystal holders used with the receiver are conventional holders normally used for video detection. It has been found that a reduction of the crystal holder output jack capacity to a minimum is required to provide a better match of the transmission line to the crystal. The 50-ohm output impedance of the QK518 is matched primarily by the adjustable attenuator and the length of 50-ohm RG-55/U cable.

While the impedance match between the QK518 and the crystal cannot be ideally maintained over the entire tuning range, a sufficient match is obtained to maintain adequate crystal current at all frequencies. During normal tuning of the receiver, the d-c crystal current variation does not generally exceed a ratio of 4 to 1. Part of this variation results from the normal power fluctuation of the QK518 during tuning.

Current Range

It has been found that a range of d-c crystal currents of from 1 ma at 10 kmc to 4 ma at 60 kmc is sufficient for harmonic mixing. This represents an approximate range of fundamental local oscillator power applied to the crystal of from 1 mw to 10 mw. The optimum value of crystal current is determined by adjusting the local oscillator power applied to the crystal for a maximum signal-to-noise ratio. The normal values of crystal current are not excessive for the standard crystals. Continued use of crystals operating under these conditions has shown no noticeable loss of sensitivity from effects of crystal current.

Frequency-Selective Tee

The use of a single coaxial input cable from the crystal mixer to the receiving system requires that two-way signal transmission take place. This consists of the transmission of the local oscillator signal from

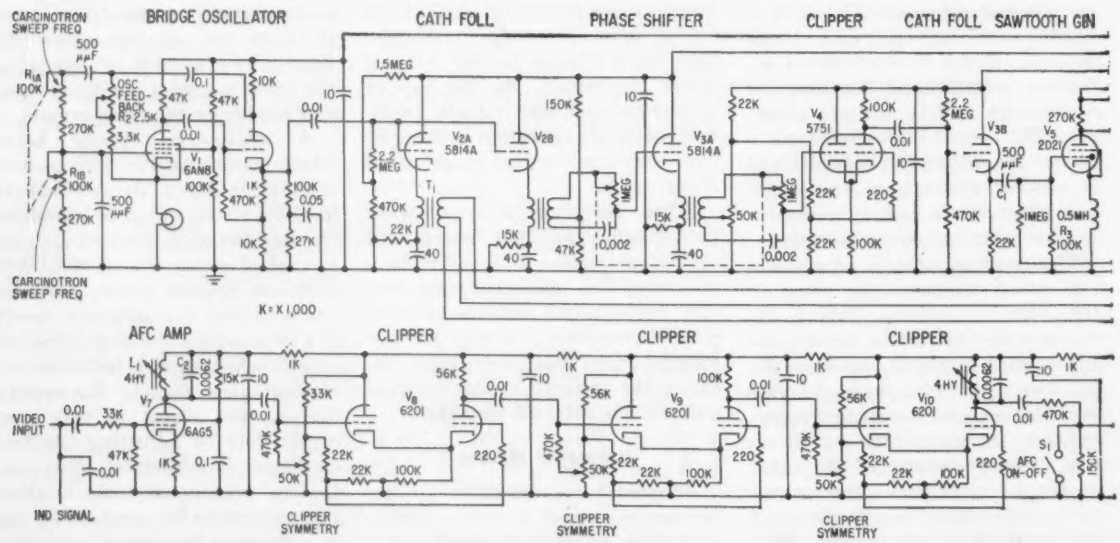


FIG. 6—Control unit of receiver system provides centralized control and monitoring facilities. Automatic frequency control provides dynamic

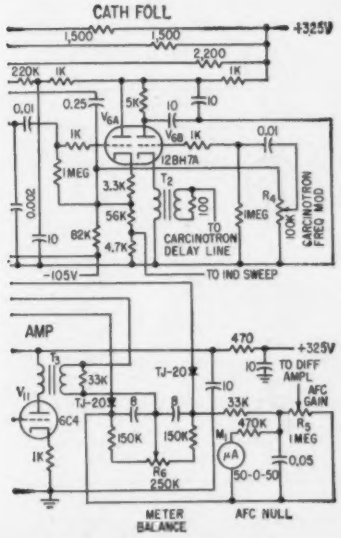
the receiving system to the crystal mixer and the transmission of the i-f signal in the opposite direction. This method of operation requires that a frequency-selective tee be employed to provide signal separation and isolation.

The frequency-selective tee developed for this purpose is shown in Fig. 3. The local oscillator signal is introduced into arm *A* and is coupled through the 15-$\mu\mu$f capacitor to arm *B*. This section of the frequency-selective tee acts as a 50-ohm transmission line for frequencies between 2 and 4 kmc.

Arm *C* is isolated from the transmission path at these frequencies by the transmission-line filter located in arm *C*. This filter is a varying-impedance low-pass filter with a frequency cutoff at 1.2 kmc. The filter consists of six low-pass sections which provide an attenuation characteristic as shown in Fig. 4.

The lumped capacitance located in arm *A* has negligible reactance to the 2- to 4-kmc local oscillator signal. The vswr of the transmission line from *A* to *B* is maintained at less than 2 to 1 over the local oscillator frequency range as shown by Fig. 5.

The second transmission path of the frequency-selective tee is from arm *B* to arm *C*. The i-f signal entering arm *B* is partially isolated from arm *A* by the reactance of the lumped capacitance. The transmission-line filter located in arm *C* appears as a low loss, 50-ohm transmission line to the i-f signal. The isolation of arm *A* afforded by the 15-$\mu\mu$f capacitor is sufficient to provide negligible i-f signal loss. The path from arm *B* to arm *C* furnishes d-c continuity permitting crystal current to be monitored in the receiving system.



signal range greater than 45 db

Control Unit

Centralization of the controls and meters necessary for adjusting and monitoring the receiving system is provided by the control unit shown in Fig. 6.

Internal oscillator V_1 is a lamp-bridge oscillator which generates a 90-v peak-to-peak sine wave for the purpose of establishing a reference frequency for the local oscillator sweep circuit and for the afc circuit.

The frequency of the oscillator (925 cps to 1,075 cps) is set by control R_1. The level of the output voltage is set by oscillator feedback control R_2. The oscillator output is coupled to the grids of both halves of tube V_2. Cathode follower V_{2A} feeds into transformer T_1 which furnishes a phase-reference signal to the afc phase detector. This output is a center tapped 280-v peak-to-peak sine wave.

Tubes V_{2B} and V_{3A} comprise an adjustable phase shifter which provides 300-deg phase displacement of the 1-kc signal. This phase adjustable signal is applied to symmetrical cathode-coupled clipper V which provides a 60-v peak-to-peak square-wave output coupled through cathode follower V_{3B} to the differentiating circuit C_1-R_3. Positive pulses appearing across R_3 trigger sawtooth generator V_5. Tube V_{6A} provides bootstrap action for the sawtooth generator. The sawtooth voltage is coupled to Carcinotron frequency modulation control R_4.

The voltage across R_4 is coupled to cathode follower V_{6B}. The secondary impedance of T_2, located in the cathode circuit of V_{6B} is less than 50 ohms and the available peak sawtooth voltage across the secondary is 13 v. The secondary of T_2 is in series with the Carcinotron delay line ground and the Carcinotron power supply common and provides frequency modulation of the carcinotron.

Output of tube V_{6A} is coupled to the horizontal sweep input terminals of the monitor oscilloscope providing the indicator sweep.

Afc Circuit

Input to the afc amplifier circuit is obtained from the crystal detector output of the i-f amplifier. The input waveform is the 1-kc swept i-f amplifier bandpass characteristic curve having an amplitude between i-f amplifier saturation and the i-f amplifier noise level.

The afc amplifier input circuit is a high-gain selective stage comprised of V_7 and tuned circuit L_1-C_2. This selective stage removes the harmonic components from the input signal and furnishes a 1-kc sine wave to the grid of V_8. Stages V_8, V_9 and V_{10} are cathode-coupled clippers which symmetrically limit the 1-kc signal and provide a signal output with a constant amplitude over a dynamic range of input signals of greater than 50 db. The final cathode-coupled clipper plate circuit contains a 1-kc high-Q tuned circuit which provides a sine-wave output. This output is coupled to the grid of amplifier V_{11}.

Transformer T_3 in the plate circuit of V_{11} couples the 1-kc sine wave to the afc phase detector. The phase detector compares the phase of this signal with the phase reference signal obtained from the output of V_2.

The phase detector output is a d-c voltage which appears across afc gain control potentiometer R_5. For a 90-deg phase relationship between the phase signal and the phase reference voltage, detector output is zero; for a 0 or 180-deg phase relationship, the output is either ±30 v d-c. The output voltage metered by M_1 is coupled to a differential amplifier in the Carcinotron power supply.

Switch S_1 in the off position removes the 1-kc sine-wave signal from the grid of V_{11}. This provides zero phase detector output voltage and permits meter balance potentiometer R_6 to be adjusted for a zero afc null meter reading.

Two-Terminal

Tabulation of important characteristics of commercially available *pnpn* and *pnpm* semiconductor switching diodes. Note differences between symbols

By **T. P. SYLVAN,** Application Engineer, Semiconductor Products Dept., General Electric Co., Syracuse, N. Y.

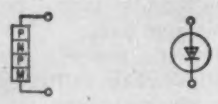
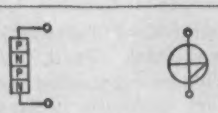
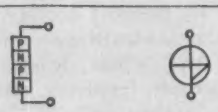
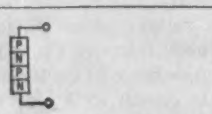
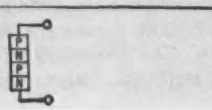
DURING the past two years, a number of solid-state switching diodes have been introduced commercially. All of the presently available diodes of this type are listed in Table 1. Specifications listed are for illustration only.

All diodes listed are *pnpn* or *pnpm* devices with two terminals. Figure 1A shows construction of the diodes together with terminology used to designate various regions and junctions. In accordance with proposed AIEE standards, the various junctions and regions are labeled according to their function and a subscript is used to designate the type of semiconductor material. This method avoids any ambiguity in identifying the regions of a *pnpn* device.

A number of manufacturers have introduced their own symbols for their devices which are given also in the table as are the present IRE symbols. General voltage-current characteristic of a switching diode is shown in Fig. 1B. Forward voltage and current (V_F, I_F) correspond to the quadrant in which the switching characteristics occur. The reverse voltage and current (V_R, I_R) correspond to the opposite quadrant. Maximum forward voltage which the device can maintain is called the breakover voltage, V_{BO} and the current at this point is called the breakover current I_{BO}.

A switching diode can be turned on by momentarily exceeding the breakover voltage. The device will then remain in the on condition as long as a forward current flows which is greater than the hold-

TABLE I—Trade Names, Symbols, Characteristics of Commercially Available

Trade Name	Manufacturer	Type Number and Material	Structure, Manufacturer's Symbol	AIEE Symbol	IRE Symbol
Dynistor	Westinghouse	WX806 (Ge)			
Four-Layer Diode	Shockley Transistor Corp.	4N20D to 4N200D (Si)			
Four-Layer Diode	Shockley Transistor Corp.	4N20AD to 4N200AD (Si)			
Four-Layer Diode	General Transistor	(Ge)			
Switching Diode	ITT Labs	CP-622 (Ge)			
Switching Diode	ITT Labs	CP-624 (Si)			

Solid-State Switches

ing current, I_H. If the forward current falls below I_H for a short time, the device will turn off and revert to the blocking state.

Reverse voltage-current characteristic of a *pnpn* diode may exhibit a blocking characteristic similar to that of a conventional rectifier as shown by the solid line in Fig. 1B. For a device having this type of reverse characteristic, the peak inverse voltage and reverse breakdown voltage are measured and specified in a manner similar to that employed with conventional rectifiers.

For some devices the reverse voltage-current characteristic exhibits a conducting characteristic as shown by the dotted line in Fig. 1B. When devices of this type are used in applications where they must withstand a reverse voltage, a series rectifier must be used. A series rectifier will increase total forward voltage drop and reduce switching efficiency.

In the next issue of ELECTRONICS, three-terminal solid-state thyratrons will be tabulated.

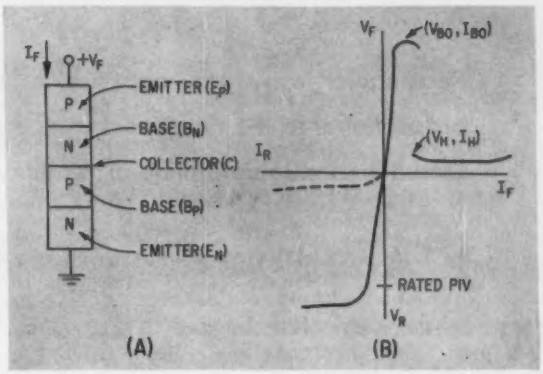


FIG. 1—Schematic diagram and terminology for a *pnpn* diode (A) and characteristic curve of *pnpn* diode with zero base current (B)

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(2) W. Shockley, The Four-Layer Diode, *Elect Ind*, p 58, Aug. 1957.

(3) J. Phillips, H. C. Chang, Germanium Power Switching Devices, *IRE Electron Devices Trans*, p 13, Jan. 1958.

Solid-State Switching Diodes

Range of V_{BO} I_{BO}	Forward Voltage Drop at Rated Current	Turn On Time, Recovery Time	Reverse Characteristic	Essential Characteristics	References
25–250 v 1–10 ma	0.5–1.0 0.5 amp	0.01 μsec	Conducts	Low turn-on time	(1) (3)
20–200 v 0–0.2 ma	0.9 v 50 ma	0.1 μsec 0.2 μsec (50 ma)	Blocks	Low breakdown currents. Close control of breakdown voltage. Pulse currents to 2 amp	(1) (2)
20–200 v 0–0.2 ma	1.0 v 300 ma	0.1 μsec 0.3 μsec (300 ma)	Blocks	Same as above except pulse currents to 20 amp	(1) (2)
40–100 v 0–0.5 ma	0.5 v 500 ma		Blocks	Low breakover current, low turn-on time	(1)
20–100 v 1–10 ma	1.0 v 10 ma	100 μsec	Blocks		(1)
20–100 v 20–200 ma	1.3 v 2 amp	5 μsec	Blocks	High-current operation	(1)

Amplitude Slicer

Rectangular waveform, obtained by simple circuit, represents a pulse width proportional to the time spent by the signal between specified voltage levels. Circuit is used to determine probability amplitude density functions

By **T. A. BICKART,** The Johns Hopkins University School of Engineering, Radiation Lab., Baltimore, Md.

WHEN SEEKING information of probability amplitude density functions in statistical measurements of signals, noise and/or determinate signals it is necessary to design a circuit capable of yielding a rectangular output pulse that has a width proportional to the time spent by the input signal between specified voltage levels. This relationship is shown in Fig. 1.

A number of circuits have been developed to produce such characteristics[1], however these methods required excessive circuitry. This paper describes a simplified technique that obtains the desired output with minimum components.

The Schmitt trigger serves as the basic building block for the amplitude window. But since off-on triggering occurs at a single level, the familiar Schmitt circuit is modified so that triggering will also take place on a second and higher voltage level. Although a conventional dual control pentode such as a 5725 will work, a pentagrid amplifier was used for its higher second control grid to plate g_m.

Triggers

In the experimental circuit developed, Fig. 2, the pentagrid amplifier V_1 turns off the plate current after the grid passes through the second voltage level. The pentagrid is operated with the second control grid clamped to the cathode during normal triggering.

The grid potential of V_1 is lifted to the triggering level by the cathode output of a phase splitter. After the input signal triggers V_1 on, it continues to increase to a second trigger level through the coupling of the plate of V_2 to the screen grids of the pentagrid. While V_1 is on, the rising input signal continues to bring the potential of the plate of V_2 down. This unclamps the suppressor from the cathode of V_1 and continues to decrease the suppressor voltage, caus-

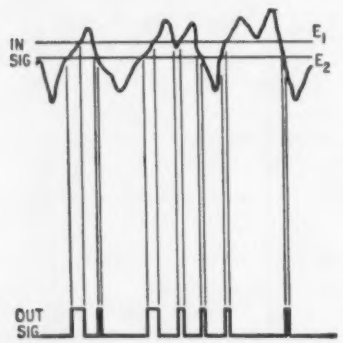


FIG. 1—Input-output characteristics of amplitude window circuit

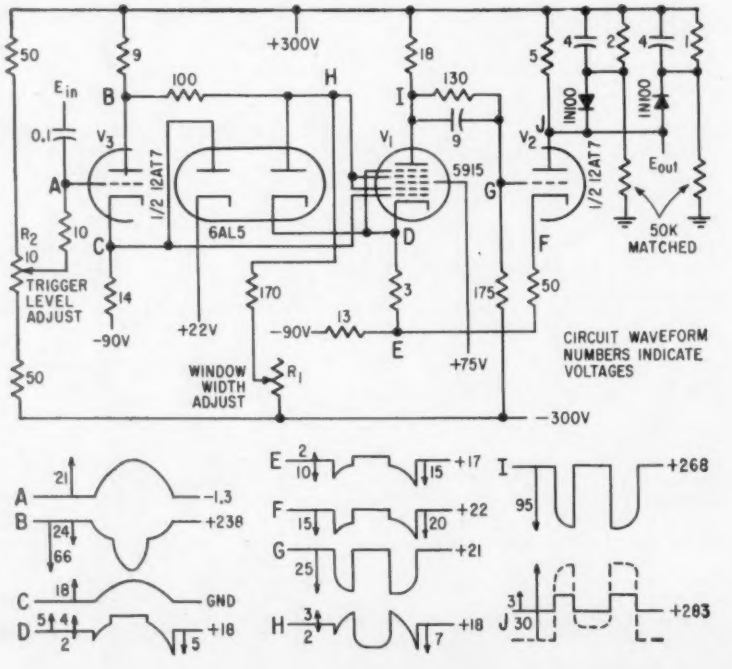
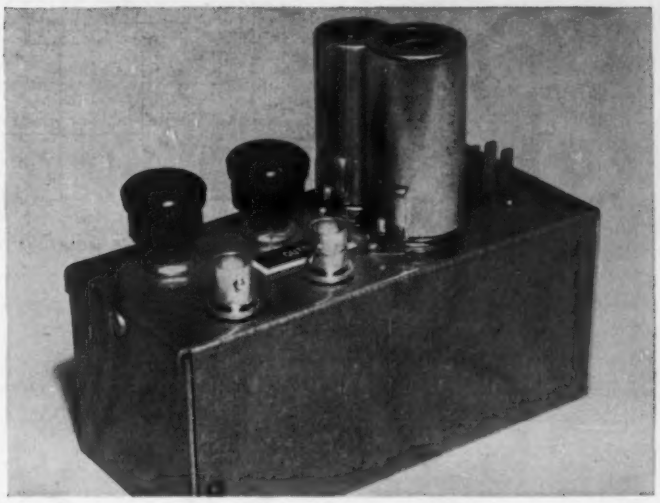


FIG. 2—Amplitude window trigger showing circuit waveform at critical points. The familiar Schmitt trigger is here modified so that triggering will take place on a second and higher voltage level. This circuit obtains a trigger on the positive portion of the input signal

for Signal Analysis



Circuit takes up a minimum amount of space

ing plate current, which is switched to the screen, to decrease.

The rising plate voltage in V_1 brings V_2 to its grid cutoff potential. Regenerative action triggers V_2 on and the plate circuit of V_1 off. After the second trigger operation has taken place, it is necessary that the cathode current of V_1 not go to zero. This would occur if the cathode were to become so positive as to exceed the control grid potential by more than the cutoff potential. If this did happen, then reducing the input signal level to a point which brings the suppressor into clamp with the cathode would not cause V_1 to trigger on, and V_2 off, for there would be no screen current to switch to the plate and cause the triggering action.

Barring this situation, V_1 is triggered on and V_2 off as the signal returns through the second trigger level. After passing back through the first trigger level, the circuit returns to its normal state.

Additional circuit considerations led to the clamping of the grid of V_1 at a potential slightly higher than the cathode potential of V_1 with the cathode current of V_1 cut off. This, in effect, prevents the phase splitter from increasing the cathode potential of V_1 and V_2 as tne second trigger level is reached through the suppressor circuit. For, if the cathode potential were to increase too far, the second trigger action could not take place, as the rising potential of V_1 would not bring V_2 to cutoff.

A caution is necessary: if the clamping potential is too low, the gain of the circuit cannot be made unity as V_2 is brought into the conducting stage.

The hysteresis encountered, as in the regular Schmitt circuit, can be treated in a normal manner[2].

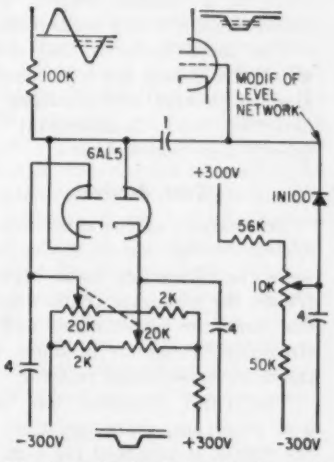


FIG. 3—Amplitude window circuit can be triggered on the negative portion of the input signal by using this modification

Window Width

With the window-width adjust, R_1, set to maximum value thus yielding maximum window width, signals are triggered between 8.5v and 6v at the first input triggering level. At the second level, signals are triggered between 22v and 21.2v. Attempts to reduce the hysteresis below 2v have resulted in the loop gain falling below unity so that the operation is no better than a clipping and gating circuit.

Clamping the plate of V_2 with IN100 diodes allows a rise or decay time, 0.1 E_{max} to 0.9 E_{max}, of 0.4 μsec and a minimum output pulse width of 2 μsec. Circuit waveforms at critical points are shown in Fig. 2.

The window width can be varied from about 15v to 10v by R_1. Further reduction results in faulty operation due to unclamping of the second control grid before the circuit has passed through its first triggering level. The window may be adjusted for a look at a given percentage of the peak-to-peak input signal at a particular level.

A circuit to obtain a trigger on the negative portion of the input signal, Fig. 3, includes a clipping network and a level-control modification: insertion of a clamp. In essence, the clipper slices a portion out of the input signal which is wider than the window width and the clamping diode clamps the negative portion of the clipped waveform at a potential just smaller than the first triggering level.

This work was carried out under contract AF33 (616)-3374.

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(2). Millman, J. and Taub, H., Pulse And Digital Circuits, Chapter 5, McGraw-Hill, 1956.

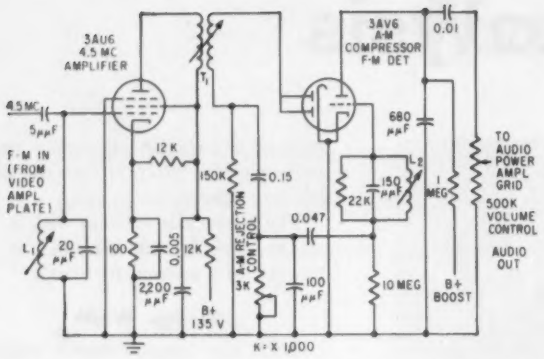


FIG. 1—Schematic diagram of complete Delta tv sound system

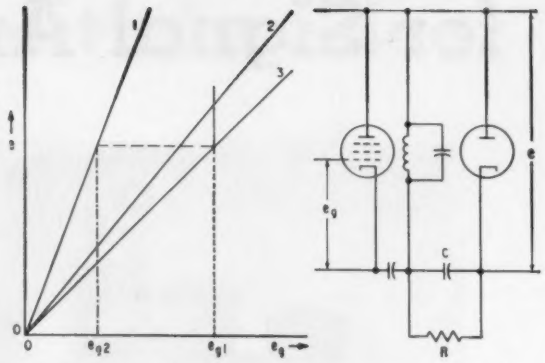


FIG. 2—Operational characteristics of diode compressor (right)

By **ROBERT B. DOME,** Consulting Engineer, Television Receiver Dept., General Electric Co., Syracuse, N. Y.

Inexpensive Sound for

Readily available low-cost tubes and components are used for new sound system. Features are: a-m compression from 12 to 24 db; peak-to-peak a-f output of 60 v with cancellation of undesired a-m fundamental

DEVELOPMENT of the Delta sound system for tv receivers was undertaken in an effort to make available a less-expensive sound system than the ratio detector.

The Delta system consists of four principal parts: The first is a 4.5-mc pentode amplifier fed from a take-off circuit connected or coupled to the plate circuit of the receiver video-frequency amplifier. Second is a diode a-m compressor connected or coupled to the plate circuit of the 4.5-mc pentode amplifier. The third part is an f-m detector consisting of a discriminator circuit and a triode operating as a power detector (bias detector or plate-bend detector) with provision for cancelling out residual fundamental frequency a-m. The fourth part consists of a volume control, audio power amplifier and loudspeaker.

For complete design details on the diode compressor see page 74

The three features that distinguish the system are a-m compression, high-level audio output f-m detection and fundamental frequency a-m cancellation.

Cost Analysis

An analysis of the ratio-detector system showed that expensive items were the 6T8 triple diode high-mu triode, the elaborate triple-winding discriminator transformer and the electrolytic capacitor in shunt with the detector self-bias resistor.

The ratio detector has good a-m rejection characteristics and the output is balanced for a-m. Its output is low, however, because of the relatively low impedance of the detector system. Because of this factor, it was necessary to add a stage of a-f amplification between the detector and power amplifier.

The schematic diagram of the Delta sound system as applied to a portable tv receiver is shown in Fig. 1. Inductance L_1 is adjusted to maximize the 4.5-mc drive to the 3AU6. Transformer T_1 is a bifilar coil. Its inductance is adjusted to tune the capacitance in shunt with the coil to 4.5 mc. Coil L_2 is tuned with its 150-$\mu\mu$f shunting capacitor to a frequency slightly above 4.5 mc.

The pentode amplifies the incoming 4.5-mc signal. When the r-f voltage between grid and ground is of sufficient magnitude, the tube acts as an a-m limiter. Output of the pentode is acted upon by the diode circuit to reduce the percentage modulation of any a-m present. Amount of compression has been

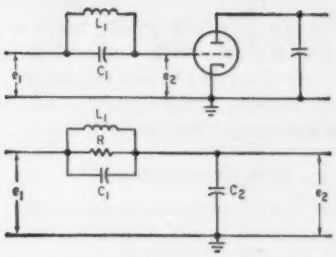
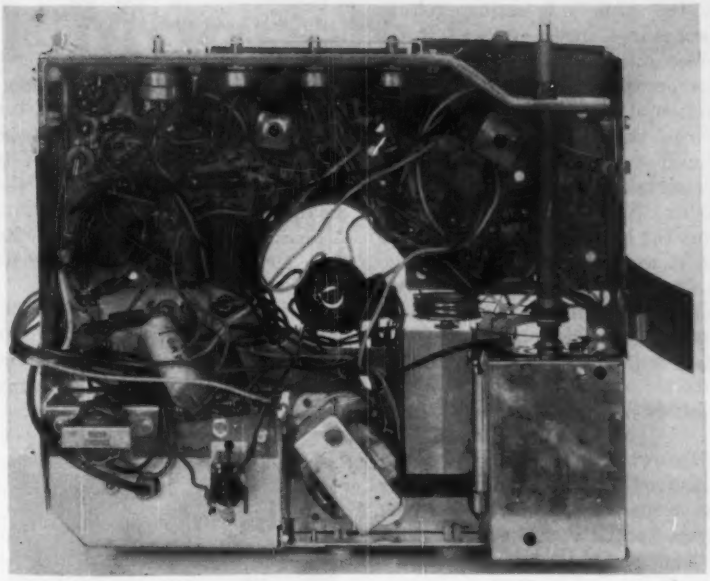


FIG. 3—Circuit diagram of discriminator



Portable tv chassis incorporating new sound system

Television Receivers

measured in the range from 12 to over 24 db.

The resultant r-f wave now only lightly modulated in amplitude, excites the grid-cathode elements of the triode. This excitation is received as follows: The 100-$\mu\mu$f capacitor is chosen so that some r-f exists across it as part of the tuned-circuit current in transformer T_1. Voltage across the 100-$\mu\mu$f capacitor is transferred to the triode grid through the 0.047-μf capacitor and tank circuit consisting of L_2 and the 150-$\mu\mu$f capacitor.

The tank circuit in conjunction with the capacitance between the triode grid and ground forms a frequency-selective or discriminator circuit whereby amplitude of the r-f signal at the grid is a function of the r-f. The grid-cathode region of the tube rectifies this r-f voltage and causes a bias to be developed as the result of grid-current flow through the 10-megohm grid leak. This voltage is stabilized by the relatively large 0.047-μf capacitor so that the triode can act as a power detector for r-f envelope changes at a-f rates.

Any residual a-m not removed by the diode compressor will also be detected by the triode. For example, during a positive-going a-m cycle, plate current of the triode will increase. This causes a negative-going audio pulse to appear at the audio output terminal. Cancellation of this effect is achieved as follows: The same positive-going a-m cycle at the diode rectifier will cause a negative-going audio pulse to appear across the 3,000-ohm a-m rejection control resistor in series with the 0.15-μf capacitor. Since the triode grid is coupled to this point by the 0.047-μf capacitor, the grid receives a negative-going pulse. The triode amplifies this pulse in the normal manner of an amplifier causing the plate current to decrease giving a positive-going audio pulse at the audio output terminal. By choosing the rejection control resistor to provide just the right amount of cancelling voltage, the fundamental frequency component of the disturbing a-m may be removed or reduced to a low level.

Diode Compressor

Function of the diode is to compress the undesired a-m that may be present on the incoming f-m signal. The principle upon which compression depends is that of a dynamic change of the r-f load line in the pentode plate circuit.

Figure 2 shows the elements making up the diode compressor together with the operational characteristics. Curve 1 represents the peak r-f output voltage obtainable as a function of pentode r-f grid voltage e_s when the diode is made inoperative by turning off its heater supply. This load is the usual tuned circuit loss load R_o. Curve 2 represents the peak r-f voltage obtainable when the diode is permitted to rectify so that the additional load of supplying the diode plate loss and the power dissipated in the d-c load resistance R is placed in shunt with the initial circuit loss resistance R_o. Curve 3 represents the direct voltage obtained across load resistor R.

Suppose there is no a-m present and the input is e_{s1} as shown by the dotted line in Fig. 2. This dotted line intersects curves 2 and 3 as shown. If a sudden negative pulse of a-m occurs, e_{s1} drops. The diode rectifier will continue to rectify un-

til the peak r-f output voltage reaches the direct voltage stored across capacitor C. To find where this occurs on curve 1, draw the horizontal line from the intersection of the dotted line with curve 3 until it intersects curve 1. This horizontal line is shown by long dashes. Now drop a perpendicular from the last-named intersection to the e_g axis at e_{g2}. Thus, it is deduced that the downward modulation capability of the diode compressor before it becomes ineffective is given by

$$m = \frac{e_{g1} - e_{g2}}{e_{g1}} = 1 - \frac{e_{g2}}{e_{g1}}$$

Meanwhile, the change in level of the voltage e across the tank is the voltage difference between curves 2 and 3 along the dotted line. If the downward modulation by this change is called M, then

$$M = 1 - \eta$$

where η is the diode rectification efficiency factor.

The modulation compression factor, expressed as a number greater than unity is

$$\eta = \frac{m}{M} = \frac{1 - \frac{e_{g2}}{e_{g1}}}{1 - \eta}$$

If $\eta = 5$, it means that the residual modulation is $\frac{1}{5}$ of the uncompressed modulation. Examination of the equation shows that the amount of compression increases as η improves or approaches unity.

Discriminator

The discriminator circuit is a simple one consisting of two capacitances and one inductance. Since one of the two capacitances is the input capacitance to a tube, the physical parts of the discriminator reduce to only one capacitor and one inductor.

The r-f circuit is shown in Fig. 3. A source of f-m waves, e_1, feeds a network consisting of a shunt-tuned tank circuit L_1C_1 in series with the tube input capacitance C_2. A resistance R shown across L_1C_1 represents the effective resistance of the tank caused by tank-circuit losses. The ratio of e_2 to e_1 is

$$\left|\frac{e_2}{e_1}\right| = \left[\frac{Q^2\,[1 - (f^2/f_o^2)]^2 + 1}{Q^2\,[1 - (af^2/f_o^2)]^2 + 1}\right]^{1/2}$$

assuming that

$$a = C_1 + (C_2/C_1) \text{ or } C_1 = C_2/(a-1)$$
$$L_1C_1 = 1/\omega_o^2$$
$$Q = R/\omega L_1$$

Figure 4 shows plots of the magnitude of e_2/e_1 for various Q's for $a = 1.04$. Translated to 4.5-mc terms, a variation of 0.011 is equivalent to 50 kc which is the maximum peak-to-peak deviation. A reasonably linear section of the $Q = 50$ or $Q = 100$ curve may be used centered at about 0.986.

In the discriminator circuit, wider separation of peaks is obtainable by increasing the factor a. Flatter slopes and, at the same time, wider peak separations are obtainable with lower Q values. For example, if a 3AV6 triode section is used, input capacitance (tube, socket and strays) is about six $\mu\mu$f. With $a = 1.04$, the tank capacitor across L_2 is.

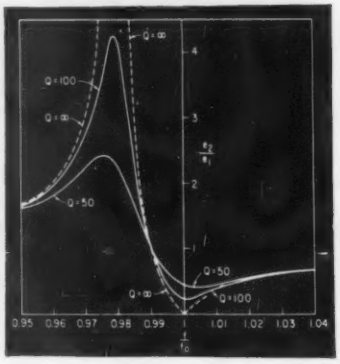


FIG. 4—Frequency response of detector network

$$C = \frac{6}{a-1} = \frac{6}{1.04 - 1} = 150\ \mu\mu f$$

The tank is tuned to

$$f_o = \frac{4{,}500\text{ kc}}{0.986} = 4{,}563\text{ kc}$$

Fixed bias for the power detector may be obtained from a suitable negative voltage elsewhere in the receiver or it may be self-generated by grid-cathode rectification. A grid leak of 10 megohms is used. An audio coupling capacitor of about 0.05 to 0.1 μf will keep distortion at low audio frequencies at reasonably low levels.

Discriminator-circuit driving voltage developed across the 100-$\mu\mu$f capacitor in Fig. 1 is found best by trial. Size of this capacitor depends upon r-f current flowing through it, plate voltage on the triode, amplification factor of the triode and shunting effect of the a-m rejection control resistor. This capacitor will lie in the range from 50 to 500 $\mu\mu$f.

A-M Cancellation

The fundamental component of the undesired a-m is cancelled by returning the grid-leak bypass capacitor through the a-m rejection-control resistor to ground instead of directly to ground. Value for this resistor will vary depending upon other circuit values and tube characteristics. The range of values is usually somewhere between 500 and 2,000 ohms. It is suggested that in the design stage a 3,000-ohm rheostat be inserted in the circuit for this resistor and that it be adjusted for best a-m rejection or fundamental cancellation.

Deemphasis

The deemphasis time constant may be adjusted by selecting the proper capacitance for the capacitor which bypasses the triode anode to ground. Three resistances in parallel form the resistive component of the deemphasis network. They are the volume control, plate-coupling resistor and the internal plate resistance of the triode.

In a typical example, assuming the coupling resistor is one megohm, the potentiometer is 500,000 ohms and the tube plate resistance is 165,000 ohms, the total shunt resistance becomes 110,000 ohms. If the deemphasis time constant τ is 75 μsec, the value for the plate bypass capacitor is

$$C = \frac{\tau}{R} = \frac{75 \times 10^{-6}}{110{,}000} = 680\ \mu\mu f$$

Detector Output Level

With a B+ of 250 v for the detector tube and with a frequency deviation of ± 25 kc, a peak-to-peak maximum audio voltage of about 60 v may be expected. The voltage depends on various circuit parameters so that it may be as low as 40 v or as high as 90 v depending upon the particular design.

This level of voltage is sufficiently high so that a conventional audio power output tube may be driven directly from the detector.

Powdered Magnets

Recent advances in powder metals, ferrites and intermetallics have greatly increased range of pressed and sintered magnet properties

By George Sideris, Associate Editor

SINTERED OR PRESSED powder permanent magnets are widely used in electronic components and instruments, particularly when large quantities of miniature magnets are required.

There has been considerable activity in this field in recent years. Table I summarizes properties reported for some of these magnet materials.

High resistivity of oxide-type magnets suits them for high frequency applications. Ferromagnetic properties of barium ferrite, particularly with substitution of iron oxide by aluminum oxide, has led to its consideration for uses at high microwave frequencies.

Research reports indicate that the full potential of superfine powders has not yet been attained with conventional materials. As with high-permeability core materials, properties can be varied widely with pressing technique.

MANUFACTURING—Conventional manufacturing techniques may be used to produce elongated single-domain magnets. Good tolerances are obtained without grinding, the magnets can be machined like cast iron, and soldered.

In processing bismanol, intermetallic crystals are produced from molten bismuth and powdered manganese. The compound is pulverized, then hot pressed in a magnetic field. Although its Curie temperature is 360 C, the bismuth will melt at 271 C and uncoated magnets corrode at room temperature.

In general, applications of sintered metals will take advantage of their physical strength, high remanence and energy product, or high-temperature stability. The oxides and ferrites give high coercive forces and resistance to demagnetization. As Table I shows, powders give a wide range of properties.

TABLE 1—**Nominal Properties of Permanent Magnets Produced by Powder Metallurgy**

Material and Process	Composition (balance: Fe)	Residual Induction (kilogauss)	Coercive Force (oersted)	BH_{max} (gauss-oersted $\times 10^{-6}$)	Flux Density at BH_{max} (kilogauss)	Elec Resistivity (μohm-cm)	Curie Temp (°C)	Density (lb/in³)
SINTERED ALLOYS								
Alnico II	10 Al, 17 Ni, 12.5 Co, 6 Cu	7.2	550	1.5	4.4	68	800	0.243
Alnico IV	12 Al, 28 Ni, 5 Co	5.5	730	1.25	3.1	68	760	0.232
Alnico V	8 Al, 14 Ni, 24 Co, 3 Cu, 1 Ti	10.5	600	3.8	8.15	47	860	0.241
Remalloy, Comol (Indalloy is similar)	12 Co, 17 Mo	10.5	230	1.1	6.9	45	900	0.295
Cunico	50 Cu, 21 Ni, 29 Co	2.5	800	0.55	—	24	—	0.3
Platinum-cobalt	77 Pt, 23 Co	4.4	2,800	3.3	—	28	600	0.46
SINTERED OXIDES								
Vectolite	Fe-Co oxides	1.6	900	0.5	0.94	225×10^{6}	540	0.113
Barium ferrite	Ba-Fe oxides	2.1	1,650	1	1.13	10^{12}	450	0.17
" " oriented	Ba-Fe oxides	3.9	2,000	3.5	—	2×10^{10}	—	0.17
PRESSED POWDERS								
Resin bonded	Fe-Co oxides	1.1–1.4	700–800	0.21–0.3	—	—	—	—
Bismanol	79 Bi, 21 Mn	4.8	3,650	5.3	2.64	—	360	0.25
Pure iron	Micropowder	5–6.6	390–600	1–1.1	3.65[a]	475	770	0.145
" "	Elong single domain	5.7–8.8	500–1,100	1.3–3.3	—	—	—	—
Iron-cobalt	Micropowder, 30 Co	6–7.5	500–625	1.5–1.7	3.83[b]	—	—	0.18
" "	Elong single domain	6–11	635–1,080	2–5	—	—	—	—
Platinum-cobalt	77 Pt, 23 Co	2.75	2,800	3.3	—	28	600	0.27

[a] At BH_{max} of 1.1 [b] At BH_{max} of 1.52 Megagauss-Oersted

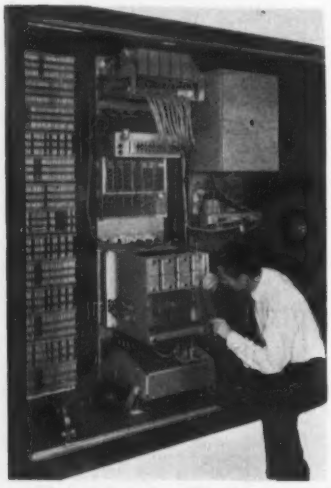
Circuits designed to provide clock signals for developing and testing large digital computers use readily available germanium transistors. Except for one oscillator, all transistors operate in either saturated or cutoff state. Other design techniques limit waste of transistor power so that system can provide peak load up to 5 amp

By **S. SCHOEN** Data Systems, Norden Division, United Aircraft Corp., Gardena, Calif.

Transistors Provide

DEVELOPMENT of several large digital data-processing systems required circuits to provide the basic timing and gating signals. Since the equipment is completely transistorized, use of transistors to generate the computer clock was investigated. Several system and circuit techniques that were used to provide controlling clock signals for digital computers containing several thousand transistors are described.

For this application, transistor switching circuits had to be capable of high speed and also of controlling high peak currents. Although reliability was the major design consideration, other factors included cost, component availability, ease of fabrication and interchangeability. For example, all circuits use commercially available germanium transistors.



Use of commercially available parts and standardized circuits limits cost of computer clock generator

Requirements

The clock circuits provide 0.25- to 0.6-μsec pulses with rise and fall times of about 0.1 μsec. Repetition rates are 150 to 750 kc. Peak transient load current is typically 3 to 5 amp. Load is primarily capacitive and may vary appreciably during the pulse.

The load consists mainly of normally nonconducting trigger transistor inputs to bistable circuits. Input impedance of these transistors under transient conditions is considerably influenced by whether they are cut off, active or saturated. Clock pulse amplitude (6 to 8 v) must be kept reasonably constant, since the trigger transistors are operated as voltage-threshold devices.

Two other features are incorporated in the clock circuits to aid design and testing of large computers. One is provision for operation either as a continuous clock or as a gated clock comprised of an arbitrary number of pulses. The second, particularly useful when troubleshooting a large system, is operation at either a slightly higher or a much lower clock repetition rate. The clock circuit can be actuated by an external vfo or by a pushbutton that provides a single clock pulse.

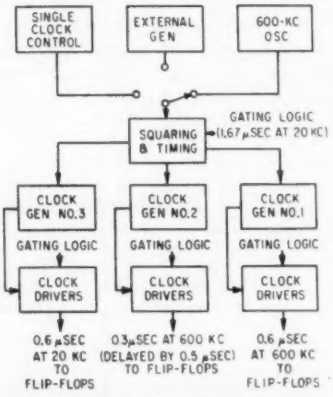


FIG. 1—Basic clock system has 600-kc oscillator but can be operated with an external generator. Provision is also included to generate a single clock pulse

System Design

The clock circuits may be separated into a common pulse generator and a number of individual drivers. In general, multiple drivers are needed because no single high-speed transistor that is readily available is capable of providing peak currents of 3 to 5 amp.

Multiple drivers provide several

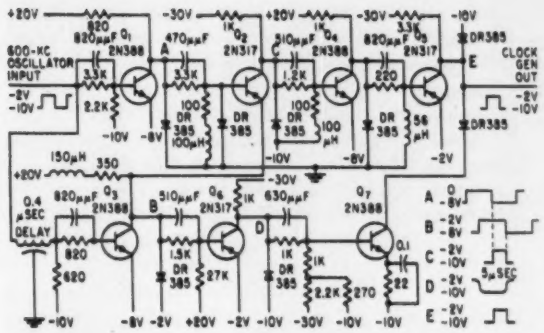


FIG. 2—Input pulse applied through transistor Q_1 switches Q_2 on. Same pulse applied through Q_2 switches Q_7 off after fixed delay

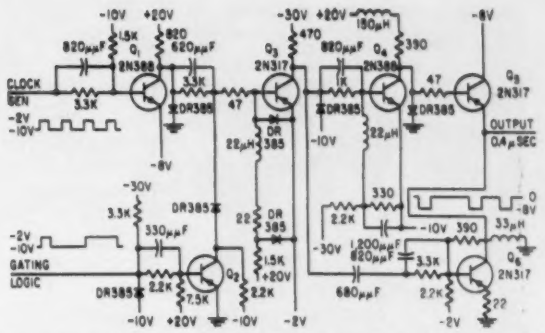


FIG. 3—By replacing conventional emitter-follower load resistor with transistor Q_3, a high impedance is presented to Q_2 during output

Computer Clock Signals

other advantages. The drivers may be individually gated for an arbitrary duration. In fabricating a large system, each clock driver may be placed physically close to the circuit being triggered, reducing ground noises, transmission attenuation and cross coupling. By making all driver circuits nearly identical, per unit fabrication cost is decreased.

A single oscillator and a pulse-forming network generate the basic waveform and repetition rate. Multiple outputs from the generator provide logical gating of entire groups of clock drivers.

A typical clock system is shown in simplified form in Fig. 1. The basic repetition rate of 600 kc is set by a sine-wave oscillator. Frequencies other than that generated by the oscillator may be supplied to the pulse-forming network by an external generator. Single clock operation is provided by a pushbutton controlled flip-flop.

Signals from the oscillator or external generator are partially shaped in the squaring and timing circuit. Delay circuits, which provide for arbitrary phasing of the various clock signals, are included in this network. Also included is provision for a logical gate that in this example provides a 20-kc repetition rate.

Three different clock-generator outputs are provided: 600-kc pulses, 600-kc pulses delayed a fixed amount from the first output, and 20-kc pulses. These outputs are supplied to the clock drivers, which set the actual pulse width used to trigger the flip-flops. In the above example, two widths are required.

Circuit Design

Accurate control of clock repetition rate is obtained with a crystal-controlled oscillator. Distortion-free waveforms are unnecessary, since eventual output is a series of pulses. The oscillator is the only circuit in this completely transistorized clock system that does not use transistors as switches operated either in a saturated or cutoff state.

The squaring and generator circuits provide an output signal whose waveform is relatively independent of input signal waveform. Input may be sine or square waves at any frequency from d-c to one mc. The input signal is amplified by the squaring circuit to provide a relatively fast rise time. Only the leading edge is used in determining pulse width.

Forming Pulses

One technique that may be used in forming the pulse is shown in Fig. 2. The leading edge of the input signal is amplified by Q_1 and applied to the base of normally cut off Q_2, switching it on.

The same leading edge is passed through a delay line and amplified by Q_2. The negative-going, delayed signal is then applied to the emitter of *pnp* transistor Q_3, cutting it off again.

Although there are modifying effects, such as trigger delay and hole storage, pulse width (on time of Q_2) is essentially determined by the delay line. Since the delay line is a passive element, output is relatively unaffected by typical compo-

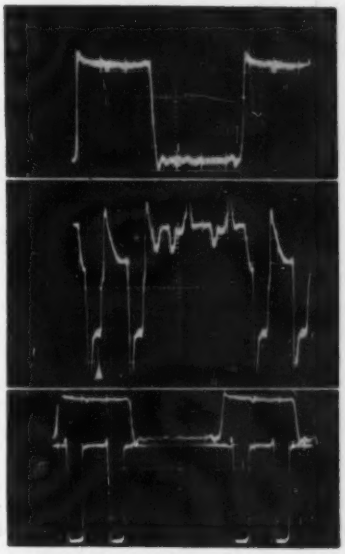


FIG. 4—Gate at top passes input at center to Q_3 in Fig. 3. Bottom shows clock driver output

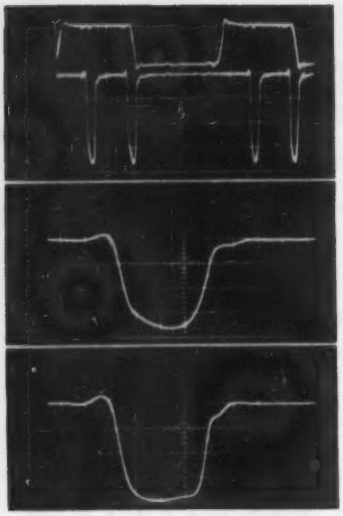


FIG. 5—Gate and resulting clock output are shown at top. Center and bottom waveforms, on expanded time scales, show output when driving thirty and ten flip-flops, respectively

nent and environmental variations or by input signal waveforms. The pulse is amplified to provide an input signal for the clock drivers.

Drivers

When driving a high-current load, it is frequently difficult to maintain a good wave shape at the trailing edge of the pulse.

At the end of the pulse, the output transistor is cut off and load capacitance must be discharged through the collector resistor. Instead of a small collector resistance, which is wasteful of pulse power, transistor Q_7 provides a low-impedance path for discharging circuit capacitances.

This stage, which is normally saturated, is cut off by Q_6 for the duration of the output pulse. At the end of the pulse, Q_7 is switched on and provides the low-impedance path. The 22-ohm resistor in series with the emitter of Q_7 limits steady-state current through it that might result from an inadvertent short circuit between collector and ground during testing.

Individual driver circuits have been designed to trigger thirty flip-flops. In addition to transistor load on the driver, there is a large capacitive load caused by a computer requirement for integrating networks and also by wiring capacitances. Peak current supplied by each driver is 400 ma. Assuming basic pulse width is maintained by the clock generator, additional shorter-duration clock pulses may be obtained by altering reactive time constants of the input networks to the high-frequency switching transistors.

Gating Circuits

Since the same logical signal may be applied to a large number of clock driver circuits, loading of the gating signal by the driver must be limited. Gating should also be done at a low current level to limit load on the gating signal.

The gating circuit used in one application is shown as part of the clock driver in Fig. 3. The clock pulse is amplified by Q_1, and the gate controls the state of Q_2. With Q_2 cut off by the gate, it appears as an essentially open circuit across the output of Q_1. Therefore, the clock pulse is applied, unattenuated, to the base of Q_3.

When the gate saturates Q_2, a low impedance appears across the output of Q_1. If the effective input impedance of Q_3 is high compared to the shunting impedance of Q_2, the clock signal will not exceed cutoff bias of Q_3. The 47-ohm resistor in series with the base of Q_3 keeps the input impedance high compared to the saturated gating transistor.

This circuit provides effective gating action with negligible insertion loss. Typical waveforms are shown in Fig. 4. The upper waveform is an arbitrarily selected gating signal. The center waveform, which is the input signal to Q_3 at the junction of the 47-ohm and 3,300-ohm resistors, illustrates gating action. The lower waveform is the output of the clock driver circuit.

Driver Output

It is difficult for the driver output stage to provide a satisfactory pulse wave shape to the type of dynamic load encountered. An additional complicating factor is the computer requirement for negative-polarity clock pulses, which would normally imply use of *npn* output transistors. However, the only readily available high-frequency transistors were *pnp* types.

In one application, transformer coupling was used. For applications with higher clock pulse-repetition rates, transformer coupling became increasingly troublesome. Conventional emitter followers also have limitations. With reactive loads, it is difficult to prevent the emitter follower from being cut off at the end of the pulse. The load and distributed capacitances must then be discharged through the emitted load resistor.

To obtain sufficient transient response, this resistor must be made quite small, which is wasteful of current during the pulse.

An emitter follower circuit that has provided good performance at frequencies approaching one mc is shown in the driver circuit of Fig. 3. The conventional emitter load resistor is replaced by Q_6. This transistor conducts when output transistor Q_5 is cut off.

A positive pulse from the collector of Q_2 applied to the input of Q_6 switches it off. The same pulse, amplified and inverted by Q_4, switches on output transistor Q_5. Since there is one less stage between it and the input signal, Q_6 is switched off slightly before Q_5 is switched on. With the high impedance presented by Q_4, essentially all output current that Q_6 can furnish is provided to the load.

At the end of the pulse, Q_6 is switched on and provides a low-impedance path to discharge the external load and distributed capacitances. As in the generator circuit, the 22-ohm emitter resistor of Q_6 limits steady-state current.

Although this circuit required two transistors, performance is sufficiently better than a conventional emitter follower to warrant its use for high-frequency circuits. Load transistor Q_6 is normally conducting in the absence of a clock pulse. However, average dissipation is negligible, since its return to the power supply is through the normally cut off output transistor, Q_5. Also, since it is normally conducting, Q_6 serves as a low-impedance clamp to maintain output d-c level invariant with respect to changes in repetition rate and load. Typical waveforms are shown in Fig. 5.

SRV-215

Frequency range.....34.2 to 35.4 kmc
Electronic
tuning range .....110 megacycles
Vibration .....1 mc p-p (10g. freq.: 10-1,000 cps)
Warm-up drift .....±10 mc (max.)

New Sperry klystron for K_a band has 110 mc electronic tuning range

- **Frequency stable within 10 mc from sea level to 70,000 feet**
- **Fixed-gap design with locked tuner to take missile shock and vibration**
- **Delivers up to 1 watt of pulsed power**

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In addition to its extremely wide electronic tuning range of 110 mc from 34.2 to 35.4 kmc and its low tuning torque, the SRV-215 is outstanding for frequency stability at all altitudes–a key factor in airborne applications. This new tube combines wide tuning range with exceptional frequency stability under extreme environmental conditions and features long operating life.

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Diode-Compressor Data

Basic diode-compressor circuit design is possible with data presented. Diode's function in tv audio is to compress the undesired a-m that may be present on the incoming f-m signal basic circuit

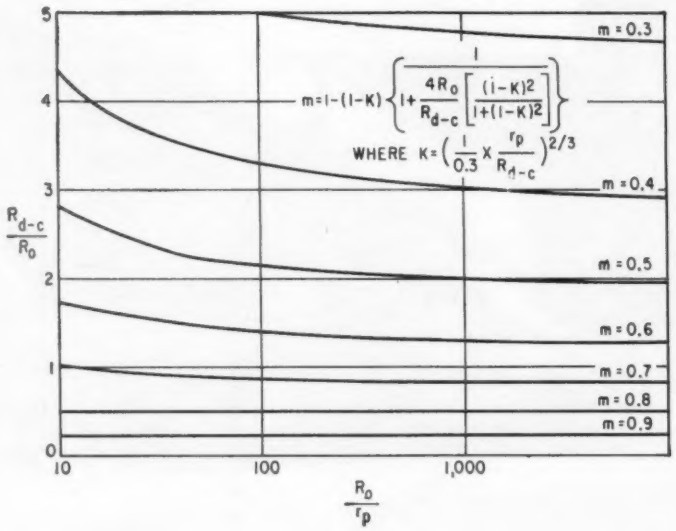
By **ROBERT B. DOME,** Consulting Engineer, Television Receiver Dept., General Electric Co., Syracuse, N. Y.

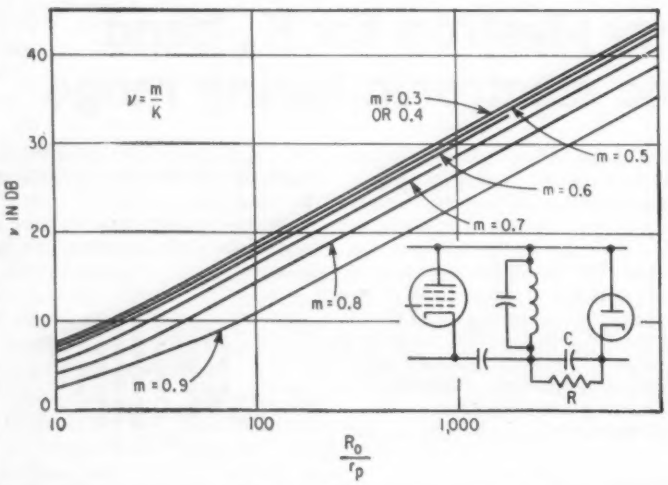
DOWNWARD MODULATION capability of the diode before it becomes effective is expressed as shown in the upper curve set. Quantity R_{d-c} is the diode load resistance, R_o is the tank-circuit resonant impedance and r_p is the diode internal plate resistance.

Modulation compression factor is shown in the lower curve set.

These equations are valid if $r_p/R_{d-c} < 0.04$.

The upper graph shows a plot of R_{d-c}/R_o vs R_o/r_p for various values of m. The lower chart shows the diode compressor circuit and performance curves of ν expressed in db vs R_o/r_p for various values of m.





Given a diode with an r_p of 1,000 ohms, R_o of 68,000 ohms and desired m of 0.5:

(1) Calculate $R_o/r_p = 68$

(2) Determine R_{d-c}/R_o from the upper curve set.

At $R_o/r_p = 68$ and at $m = 0.5$, $R_{d-c}/R_o = 2.2$. Therefore, $R_{d-c} = 2.2 \times 68{,}000 = 150{,}000$ ohms

(3) Determine ν from the lower curves. At $m = 0.5$ and $R_o/r_p = 68$, $\nu = 16$ db or 6.3 times.

(4) Solutions are valid because $r_p/R_{d-c} = 1{,}000/150{,}000 = 0.0067$ which is less than 0.04

Diode load shunt capacitor equation is $C = \nu/4fm\ R_{d-c}$ where f is the lowest frequency to be protected. Assuming $f = 140$ cps, then $C = 0.15\ \mu$f.

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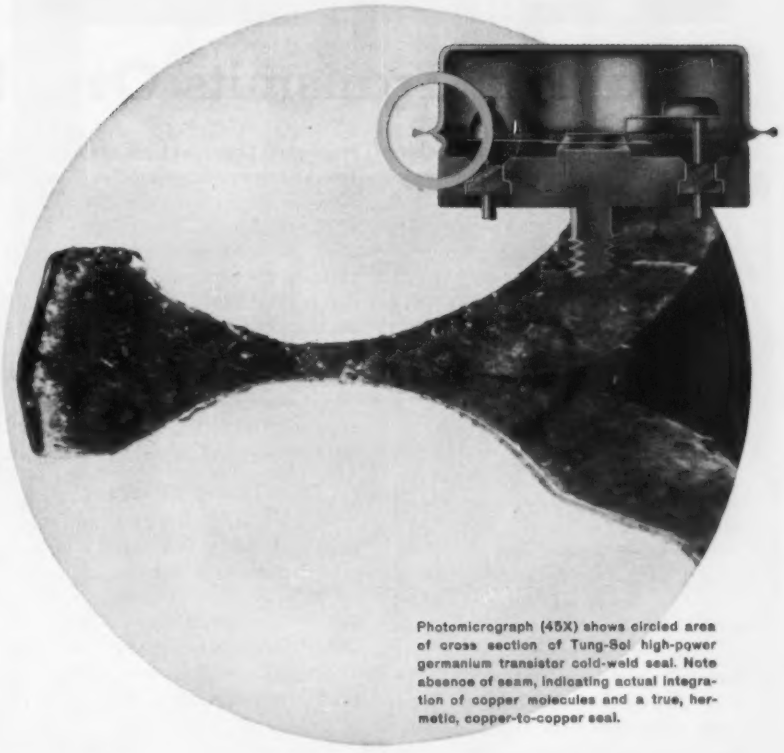
- Vacuum-tight, moisture-proof cold-weld seal lasts even through "breathing" over long life operation.



Photomicrograph (45X) shows circled area of cross section of Tung-Sol high-power germanium transistor cold-weld seal. Note absence of seam, indicating actual integration of copper molecules and a true, hermetic, copper-to-copper seal.

Once again Tung-Sol shows the way. Now, for the first time, Tung-Sol brings designers high-power germanium transistors with quality benefits of the advanced cold-weld seal.

The new Tung-Sol types feature a stud-mounted package and maximum collector current of 13 amps. Military environmental tests combine with the radioactive gas leak detection test to assure maximum reliability.

Technological advancements such as this keep Tung-Sol ahead of the field. For full data on the new high-power switching transistors . . . to meet any need with the latest in transistor design and efficiency, contact: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey.

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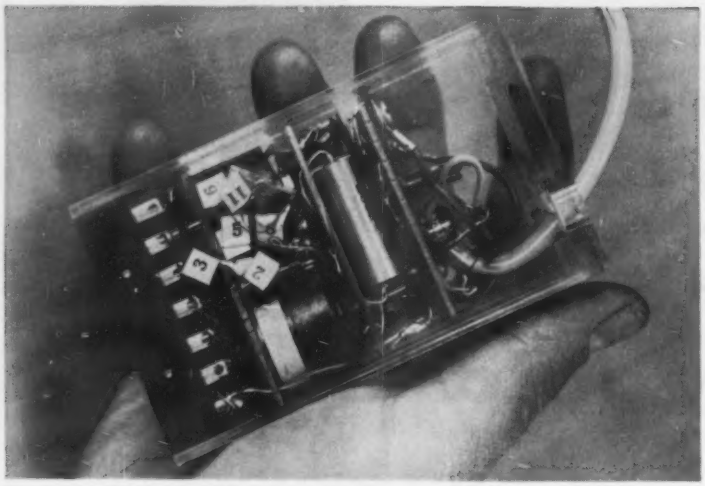

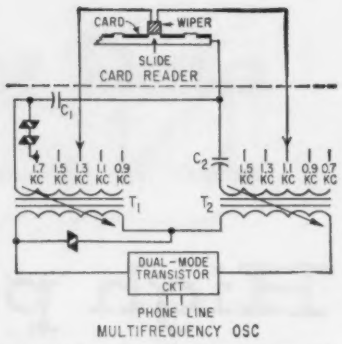

FIG. 1—Transmitting unit provides 15 different composite signals to provide digital data for phone-line transmission.

Transistorized multifrequency oscillator operates from phone-line power

Data Unit Transmits Over Phone Lines

TRANSMITTING data in machine language over conventional phone lines is possible with a device just developed by Western Electric. The transmitting unit, designed to complement the Dataphone system introduced last year, consists of a card reader and a multifrequency oscillator.

All power required by the transmitter is supplied from the central phone office. Power supplies, rectifiers, translation relays and serializing devices normally associated with remote data input systems are eliminated.

The card reader has a silver-plated bronze slide that is moved under a series of eutectic silver wipers by a conventional dial-phone ratchet mechanism. When a punched card is placed on the slide and the ratchet mechanism actuated, projections on the slide surface are forced through the holes and make contact with the wipers.

Oscillator

The multifrequency oscillator contains two tunable transformers, three varistors and a dual-mode transistor circuit. Each wiper in the card reader is permanently connected to a fixed-frequency tap on T_1 in Fig. 1 and to a different frequency tap on T_2.

Since there are six different volce-frequency taps and they are selected two at a time, fifteen different composite signals can be generated by the oscillator. The signals are used to represent the digits 0 through 9. One signal each is used for calling the computer attendant at the central computer, registering messages, ending messages and indicating input error. One optional signal can be used for automatically recording time or changing format of the receiver program.

Tuning Circuits

Transformers T_1 and T_2 and polystyrene capacitors C_1 and C_2 form tuning circuits which are energized by the dual-mode transistor circuit. Since the transformers have positive temperature coefficients and the capacitors negative, frequency shift resulting from temperature variations is minimized.

When a closure is made in the card reader, the two frequencies generated are combined, amplified by the dual-mode transistor circuit and fed to standard phone lines.

The dual-mode transistor circuit consists of one transistor, four diodes for polarity control, one Zener diode for voltage regulation, one varistor, five resistors and two capacitors. This circuit maintains signal intelligibility through termination impedances ranging from zero to 1,500 ohms and with phone line voltage deviations of 5 to 45 volts.

Several computer manufacturers have been licensed to make the card reader. The oscillator will be built by Western Electric and installed with the Dataphone system at a rental rate substantially less than $5 a month.

Analog Unit Tests Fire Endurance

SPECIAL-PURPOSE analog computer makes possible rapid estimates of the transient heat flow within building materials or construction.

Fire resistance tests are often performed on portions of buildings to determine how well the construction will withstand the effects of fire. However, the expense of building the test specimen and the long time required to perform the test make desirable some high-speed method for estimating fire endurance of structures.

The analog device developed at the National Bureau of Standards provides such a method by using a direct analogy between thermal and electrical circuits. This type analogy simplifies coding problems and eliminates the large assembly

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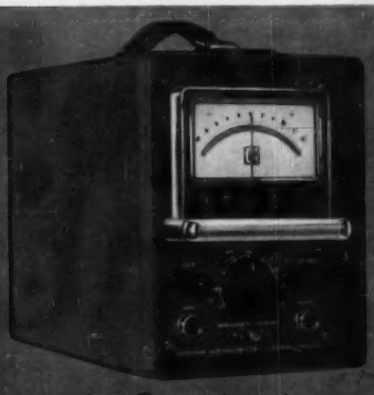
±10 MICROVOLTS TO ±1000 VOLTS



Range: ±10 microvolts to ±1000 volts, in 9 decaded steps.

Zero Drift: Less than ±1 microvolt (referred to the input) over 2-hour period.

Power Sensitivity: 10^{-14} watts at full scale.

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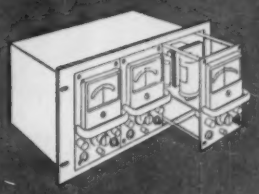
Combines direct reading voltmeter with chopper-stabilized DC amplifier ... Accuracy within ±3% (above noise level) of full scale ... Zero-center meter movement provides polarity indication without switching or lead reversal ... Rugged, all transistor, etched-circuit construction ... Illuminated mirror scale.

A twist of a knob releases chassis from hand carrying case, for insertion in 3-unit modular rack.



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of electronic mathematical-operator units which conventional computers require to solve the problem of heat transfer by conduction.

The instrument is a fast-time type, in which a problem is solved repetitively at a speed much higher than can be obtained with an actual test specimen. Essentially, it applies voltages corresponding to prescribed temperature-time conditions of a standard fire test to an electrical model representing the material under study.

Resultant temperature-time curves are displayed on a cathode-ray tube.

The equipment consists of a signal-generating unit, means for applying the signal to an electrical network, and circuitry to measure the transient voltages developed within the model.

A custom-made electrical model is prepared for each thermal problem to be simulated. A plug-in unit provides 20 network elements and discharge points. A series of resistors represents a lumped approximation to the continuous thermal resistance of the prototype, and a group of capacitors shunting the resistors to ground represents a lumped approximation to its heat capacity.

Signal Generator

The signal generator, a photoformer unit, was selected for flexibility in choice of possible wave forms and ease with which they can be interchanged. It is basically an oscilloscope with an opaque mask covering a portion of the cathode-ray tube face. The shape of the mask corresponds to the shape of the desired waveform.

A phototube with appropriate amplifier is arranged to view the crt. Combination of a feedback in the vertical plate circuit and a relaxation timing sweep on the horizontal plates forces the spot to follow the mask outline on the screen. Since voltage applied to the deflection plates is proportional to displacement of the spot, a voltage-time signal, controlled by the shape of the mask, can be taken from the plates.

An impedance converter combines the balanced but out-of-phase voltages applied to the deflecting

plates of the generating oscilloscope into a single-phase low-impedance output signal with ground as a reference level.

Discharge Unit

The discharge circuit is made up of three separate circuits. A twin triode amplifier and phase inverter supply an output that is split into two signals. A set of discharge triodes is provided for each individual section of the model.

A clamp diode functions as a reference-level generator. The last unit is necessary to balance out the potential drop across the clamp diodes and permit discharge of the network model to the ground reference level. In the original unit of 20 discharge triodes, ten twin-triode tubes were used to permit complete discharge of a 20-section electrical model.

Read-Out Oscilloscope

The viewing oscilloscope, on which the problem situation is displayed, is of a type suitable for driven-sweep operation from an external trigger signal. This facility together with the highly linear time sweep source for the signal generator are the only essential requirements of the unit. High linearity of the vertical amplifiers is not essential.

Servos Control Atomic Manipulator

Manipulator under development at Westinghouse atomic power department will permit remote dismantling of atomic equipment in nuclear power plant. Technician uses servo manipulator to take apart practice pump. In actual operation, operator would work behind shield

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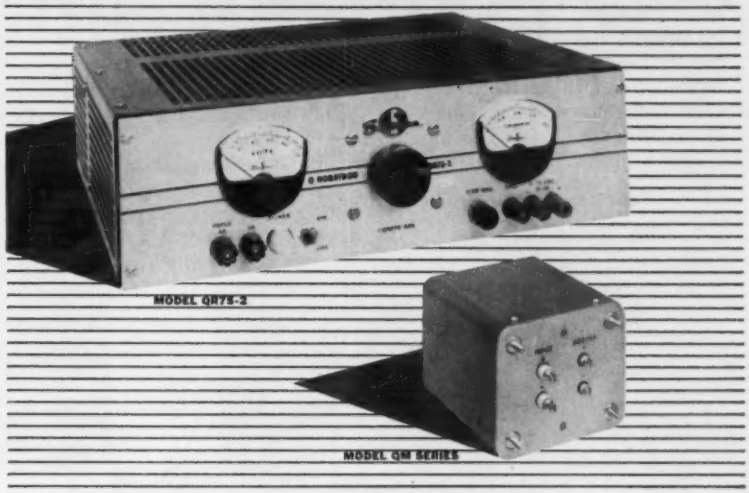

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CIRCLE 50 READERS SERVICE CARD

Plastic Microwave Antenna Horns

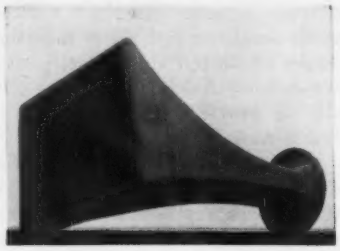
By WILLIAM L. MACKIE, Aeronautical Research Engineer, Pacific Missile Range, U. S. Naval Missile Center, Point Mugu, Calif.

LIGHT-WEIGHT radar antenna horns were required for installation on retractable masts provided on mobile radio vans. Metal antenna horns proved to be too heavy and expensive. The problem was solved by molding the horns from high-strength plastic laminate.

Fabrication Method

To obtain a dimensionally accurate horn, a plaster coat was prepared, using an electro-formed horn as a model. After drying, the cast was removed from the form, sanded smooth and coated with sealing lacquer. A hard wax mold release material was applied to the cast and oven dried.

Prior to placing the fiber-glass laminate on the plaster mold, a gel coat of No. 210 epoxy resin (Applied Plastics Co.) was applied to the mold. While the gel coat was still in a partially cured condition, four layers of No. 1542 fiber-glass cloth, each saturated with 20 percent by weight of resin, were draped on the mold. After removal of all entrapped air, the laminate was allowed to cure in air at ambient temperature. The laminated plastic was then removed from the mold, trimmed to the correct size and assembled to a brass connecting flange. Three coats of Du Pont No. 4817 silver conductive coating were sprayed on the inside of the horns, each successive coat being air dried for 15 minutes at ambient temperature.



Plastic exponentral radar horn for S-band

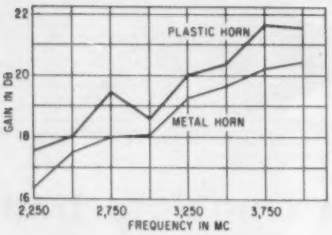


FIG. 1—Comparative chart showing gain versus frequency

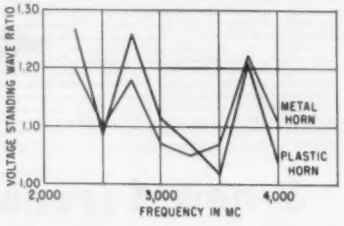


FIG. 2—Comparisen of vswr with frequency for both antenna types

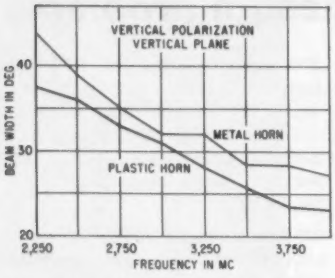


FIG. 3—Vertical beam width for the two antenna types

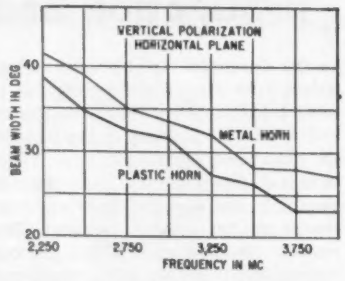


FIG. 4—Horizontal beam width for both antenna types

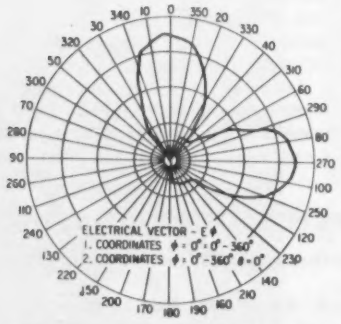


FIG. 5—Power patterns of horizontal and vertical beam widths of plastic horn at 2500 mc

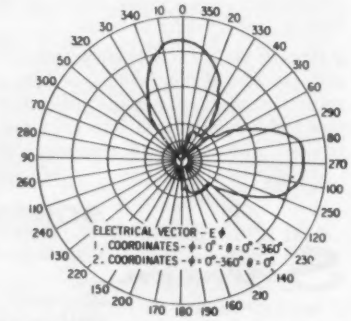


FIG. 6—Power pattern of horizontal and vertical beam widths of metal horn at 2500 mc

Evaluation Test Results

Evaluation tests were performed to determine the absolute gain and beam width of a plastic S-band horn manufactured by the procedure described. In addition, vswr of the horn was determined and a spherical coordinate system was used for interpreting directivity patterns when the field strength was measured around the Z and Y axes. Comparative plots of test results for the plastic horn and the metal horn are shown in Fig. 1-6.

A review of the data indicated that output of the plastic horn is 0.5 to 1.4 db greater than the metal horn over a frequency spectrum of 2,250 to 4,000 mc. The vswr shows the plastic horn to be comparable and, in some cases, superior to the metal horn. Summation of these advantages plus a weight advantage of three to one, indicates that this application of structural plastics is highly desirable for antennas em-

Precision Computing Resolvers

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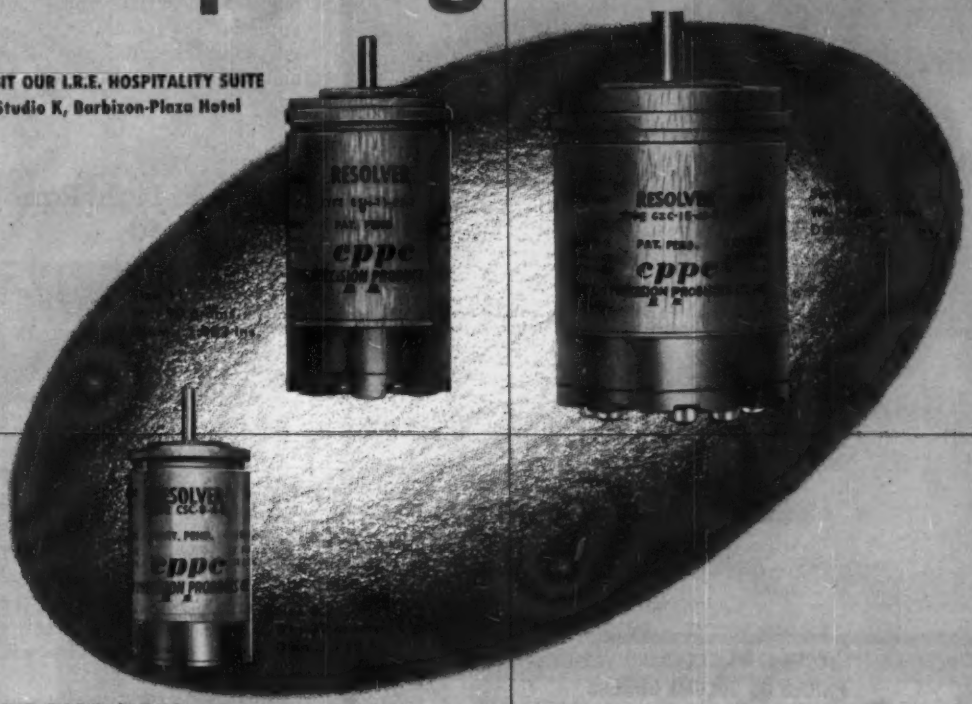

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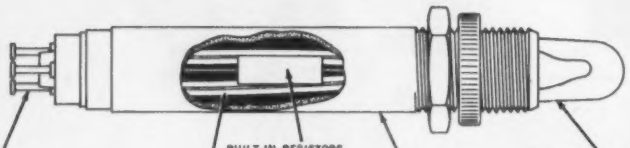

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ployed in several frequency ranges. Horns made by a similar method were for use in the C- and X-bands.

The plastic horns had other desirable features including excellent resistance to weathering in harsh marine atmospheres, dimensional stability and inhibition of fungus growth.

Applications

Possible applications include airborne navigational radar, surface antennas for air search, signal receivers for checking ground beacons and Pillbox antennas for shaped beam requirements.

Hot-Cold-Light Panel Announced

THERMOELECTRIC heating and cooling are combined with electroluminescent lighting in a wall panel developed by Westinghouse. The panel is dial-controlled, exhibits a temperature change from 55 to 120 F and provides variable intensity and color range of the light source.

Artistic Semiconductors

Part of the thermoelectric assembly is superimposed in artistic designs of anodized aluminum in front of the electroluminescent screen of the panel as shown in the accompanying illustration. The remaining portion is hidden from view behind the screen. A range of hues from blue to blue-green to

green is provided.

The panel is six ft long and four ft high. Westinghouse has no plans for commercial introduction of the device at this time.

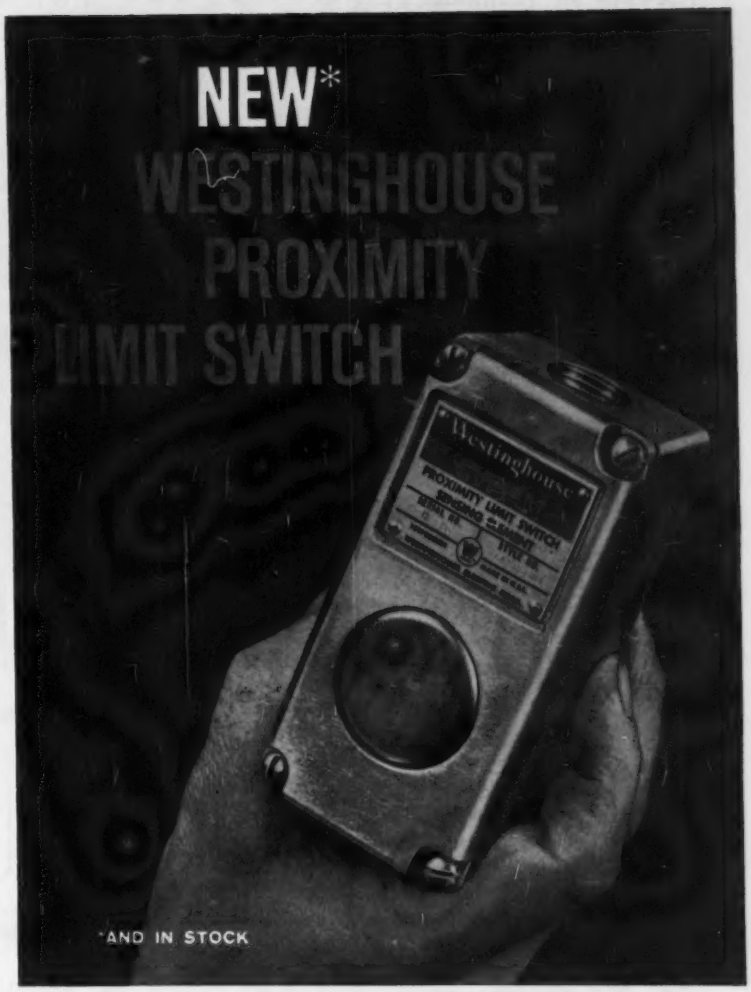
New Bonded-Shield Tv Picture Tube

Epoxy resin being applied between new tube face and safety panel

BONDED DIRECTLY to the face plate of a new 23-in. tv picture tube is the safety panel ordinarily found as a separate component in a tv set. Developed by Sylvania Electric Products Inc., the new tube has about the same height and width as a conventional 21-in. 110-deg tube. But sharper corners and relatively flat face give about 20 sq. in. of additional viewing area.

Large Sapphire Lens

Part of an infrared optical system developed by Consolidated Electrodynamics Corp. in the synthetic sapphire lens (top). It is 3¼ in. in diam. Also part of the system is the silicon dome shown



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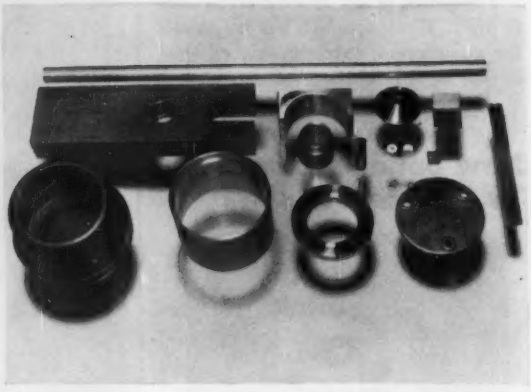
Shown, left to right, are multibarrel with detachable barrels, tilt-type barrel with mechanized screening attachment, small, double-end horizontal barrel machine and centrifugal drier



Typical parts which are barrel finished innclude ferrous, nonferrous and oxidized nickel parts. The two tiny white parts at right center are ceramic spacers

Barrel Finishing Delicate Parts

By **RALPH F. ENYEDY,** Westinghouse Electric Corp., Electronic Tube Div., Elmira, N. Y.

BARREL FINISHING to deburr, radius, polish or perform other finishing operations on parts is widely used in electronic tube manufacturing. Cost reductions by barrel finishing are often startling when compared with other methods.

Fears of "poisoning", imbedding of foreign particles, mutilation of delicate parts and assemblies formerly presented serious obstacles to barrel finishing. Apprehension is disappearing because the process has solved such problems as those given below.

Typical Operations

In bulb to anode sealing of a tube, some scrap resulted from cracked glass, leaky seals and misalignment. The metal anode was worth salvaging if all glass could be removed (Fig. 1a), but expensive hand methods were unsuccessful.

The parts were ground in a rubber-lined, tilt-type barrel with ¾ inch to 1 inch bonded chips, water and a chip grinding compound. Some 500 parts were ground at a time for 4 hours. The original metal finish was regained by polishing in the same barrel with ⅞ inch soft steel diagonals, soap compounds and water.

Particles from carbonized nickel parts (Fig. 2b) separated from the metal after tubes were sealed. Parts were rolled in a large, tilt-type rubber-lined barrel with three times their volume of hardwood sawdust, 100 pieces at a time for 30 minutes. This solved the flaking problem.

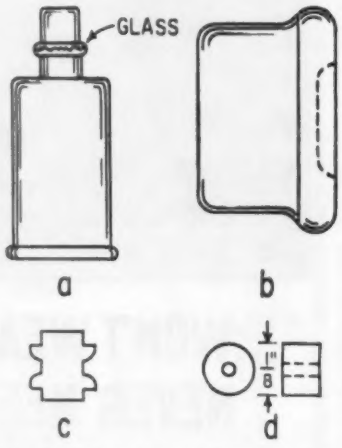


FIG. 1—Outlines of parts discussed in text

A small nickel shield, 0.005 inch thick caused trouble in its assembly into a receiving tube because 2 or more shields would stick together tenaciously through cleaning and firing (Fig. 1c). Sense of feel did not always detect dual parts. Delay and sometimes scrap resulted.

Barrel separation kept the shields separated through subsequent cleaning and firing by also removing burrs. A small horizontal barrel was used to roll 10,000 shields at a time in ¼ by ¼ by ¾ Green Carborubs. After separation from the media, the parts were barrel dried in ground corn cobs.

A ceramic part (Fig. 1d) had to be drawn into a long metal tube and spaced at prescribed intervals. The sharp edges of the ceramic gouged into the metal, thwarting spacing. Barrell finishing radiused the sharp edges without reducing the part diameter. The parts were rolled 4 hours with ¼ by ½ inch bonded chips in a small horizontal barrel. Water was used but no compound was necessary.

Connectors Tested in Portable Force Gage

PRODUCTION TESTING of tensile strengths of solderless electrical connections is handled at AMP Inc., Harrisburg, Pa., with a tester built around a portable precision force gage. An air cylinder and piston, controlled by a speed-regulating hydraulic dash-pot, is the other major part of the tester.

As shown in the photos, the crimped lead is slipped into a notched attachment on the tension

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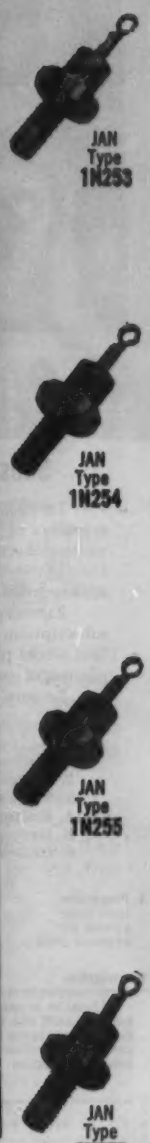

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1N253	100	1000	—	—	0.1*	Stud	1024A
1N254	200	400	—	—	0.1*	Stud	949B
1N255	400	400	—	—	0.15*	Stud	990B
1N256	600	200	—	—	0.25*	Stud	991B
1N538	200	—	750	250	0.350†	Axial Lead	1084A
1N540	400	—	750	250	0.350†	Axial Lead	1085A
1N547	600	—	750	250	0.350†	Axial Lead	1083A

*Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current; case temperature 135° C.

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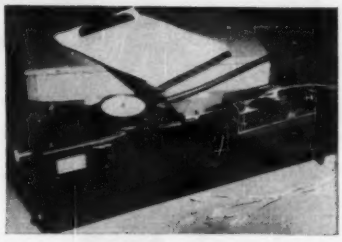
head of the force gage. The wire is gripped in jaws actuated by the air piston. When the air cylinder handle is depressed by the operator, the cylinder moves quickly until the jaws, in closing, touch the wire.

Under control of the dashpot, the piston slows to the preset speed called for in the test, pulling the wire until the crimped connection fails. The force gage dial holds the reading of the force exerted at the instant of failure.

Wire is pulled to breaking point by air cylinder



Closeup of crimped connector in notched tension head

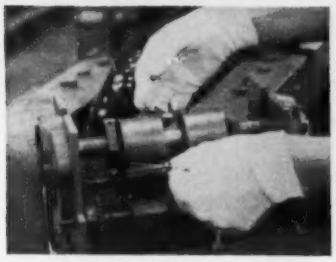
The air cylinder returns to its starting position when the handle is released and the jaws open to receive the next wire. The gage is reset to zero with a button on the gage. The instrument is a compensated spring-type gage made by Hunter Spring Co., Lansdale, Pa. It has a maximum capacity of 100 pounds $\pm$ ½ pound.

Rollers Straighten Bent Axial Leads

AXIAL COMPONENT leads can be quickly straightened with a roller device. The photos show such a device being used to straighten bent resistor leads at Corning Glass Works' electronic components plant, Bradford, Pa. Bent leads

would cause the resistors to be unevenly coated on an automatic silicone painting line.

Lead straightener in use at head of resistor painting line



Leads are dropped into space between roller and anvil

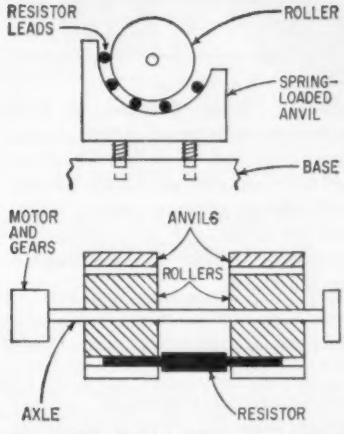


Fig. 1—End view and cross section of lead straightener

A pair of smooth round steel rollers rotate in 2 semicircular spring-loaded anvils, as shown in Fig. 1. As leads are fed into the space between the rollers and anvils, the springs are compressed. The resulting spring pressure is sufficient to straighten the leads as the rotation of the rollers carries the leads from right to left. The rolling action also keeps the leads round.

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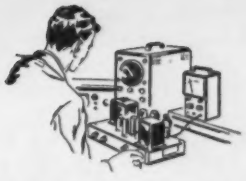

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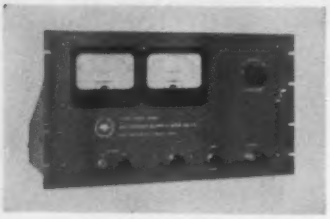
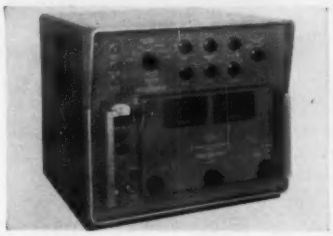


D-C Power Supply transistorized

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif., has developed a 24-32 v at 10 amperes transistorized precision type laboratory d-c power supply. Incorporating a dual regulatory system consisting of magnetic amplifier and transistor amplifier, it is designated model No. MTR28-10. It operates from an a-c input of 105-125 v, single phase, 60 cps. For further information write directly to the company.

Signal Generator 4,450 to 11,000 mc

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. Model PMX microwave signal generator covers the frequency range of 4,450 to 11,000 mc by use of two interchangeable plug-in tuning units. This versatile test instrument generates internal pulse, square wave or f-m signals—or can be externally modulated. Range of internal pulse capabilities include 0.2 to 10 μsec variable width; 2 to 2,000 μsec delay; and 10 to 10,000 pps repetition rate. **Circle 200 on Reader Service Card.**



Tv I-F Pentode three types

CBS-HYTRON, Danvers, Mass. Three heater versions of a wide-band, high-frequency pentode have been announced. The sharp-cutoff types 3DK6, 4DK6 and

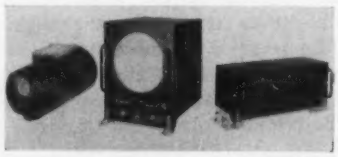
6DK6 are particularly suited for use as i-f amplifiers in tv receivers. They feature a high transconductance of 9,800 μmhos. The 3DK6 and 4DK6 are designed for use in 600-ma and 450-ma series-string sets respectively; and the 6DK6, for parallel heater operation. **Circle 201 on Reader Service Card.**

Phase Modulator 9.75 to 10.75 kmc

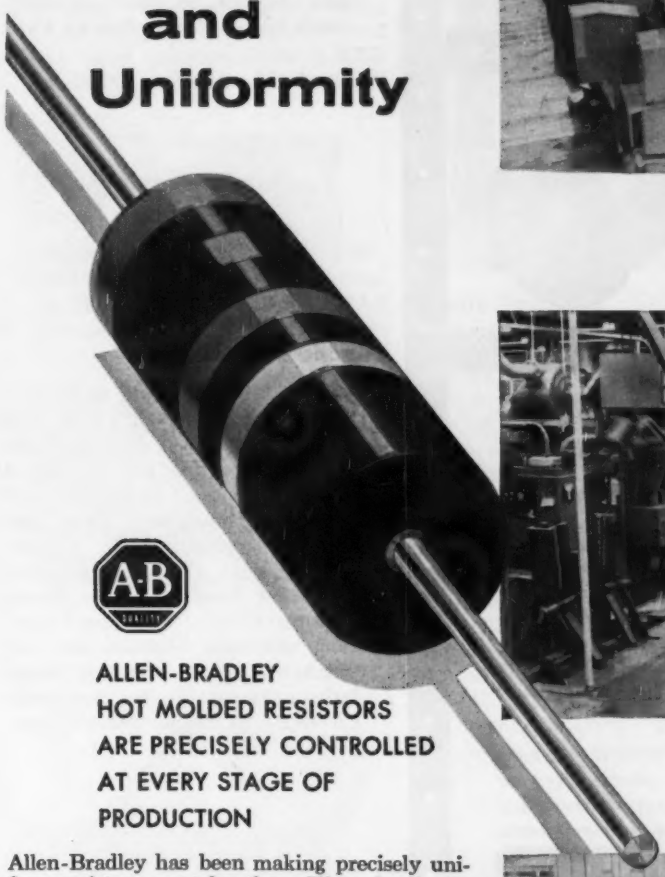
KEARFOTT CO., INC., 14844 Oxnard St., Van Nuys, Calif. Model W-183-1E X-Band ferrite phase modulator may be used as a frequency translator, side band generator, or as an electronically controlled phase shifter. Boasting a small volumetric enclosure and small insertion length (6 in. by 1⅛ in.), the new unit weighs less than 1 lb. Amplitude modulation is less than 0.3 db variation with control current. **Circle 202 on Reader Service Card.**

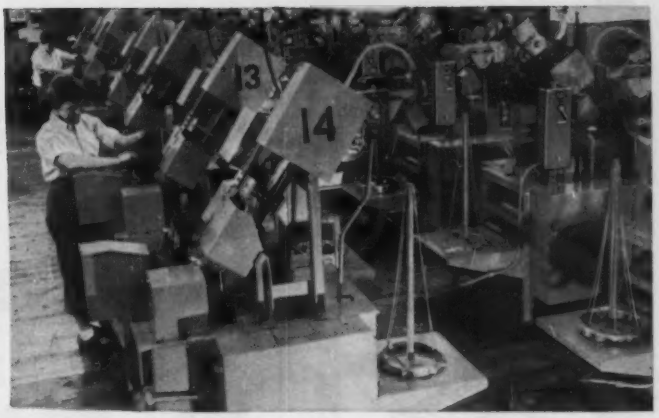
Military Tv System all-Transistor

DAGE TELEVISION DIVISION, Thompson Ramo Wooldridge, Inc., Michigan City, Ind., has developed a completely transistorized ruggedized military tv system. It consists of three components: tv camera unit; tv monitor unit; and tv control unit, which provides power and synchronization to both camera and

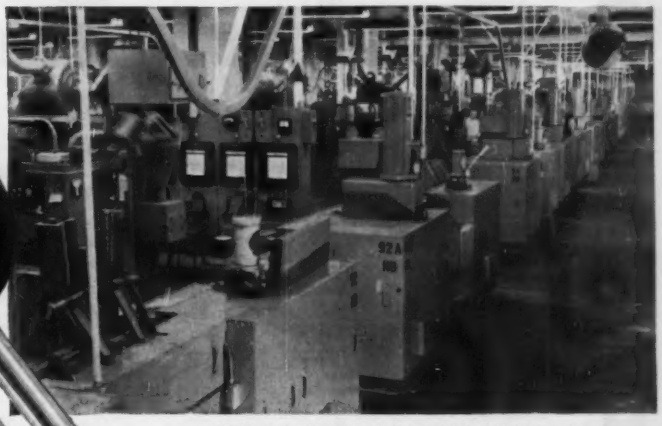


Miracle of Precision and Uniformity





AUTOMATIC HEADING MACHINES form heads on the end of lead wires to make sure they will be solidly anchored in the resistor body. Wire has been previously tinned for easy soldering.



AUTOMATIC MOLDING MACHINES take the resistance powder, insulation powder, and lead wires, and hot mold them under closely controlled high temperature into one integral unit.

AUTOMATIC COLOR CODING MACHINES apply color bands and oven-bake the enamel at high temperatures to assure that the color coding will withstand the maximum operating temperatures of 150°C and all types of cleaning solvents.

ALLEN-BRADLEY HOT MOLDED RESISTORS ARE PRECISELY CONTROLLED AT EVERY STAGE OF PRODUCTION

Allen-Bradley has been making precisely uniform resistors—not by the millions *but by the billions*—over the years. The *exclusive* hot molding process—developed and perfected by Allen-Bradley—uses specially designed automatic machines that incorporate precision control at *every* step of production. Shown here are a few of the special machines that make possible the amazing uniformity—from resistor to resistor, year after year—for which Allen-Bradley composition resistors are famous.

Allen-Bradley Co., 110 W. Greenfield Ave.
Milwaukee 4, Wisconsin
In Canada: Allen-Bradley Canada Ltd.
Galt, Ontario

ALLEN-BRADLEY
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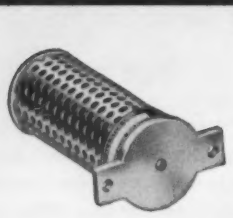
Electronic Components

LABORATORY QUALITY AT MASS-PRODUCTION PRICES

...with Bendix temperature-compensated tachometer generators*



Bendix has the facilities to give you all the precision and accuracy you want in tachometer generators—*at volume production prices.* And our volume production means *delivery when you want it.*

Most important of all, Bendix Tachometer Generators feature laboratory quality because of unique, high-precision manufacture and extensive test facilities. For example, these generators deliver accuracies within 1/10 of 1% over a wide speed range due to calibration by specially built Bendix production test equipment. Further, they're temperature-compensated over a range from —55°C to +125°C.

Bendix Tachometer Generators are available in frame sizes 10, 11, 15 and 23—and offer the latest developments in miniaturization, integral motors, and other desirable features.

THE STEP THAT PAYS. Find out today how the Bendix "Supermarket" gives you more tachometer generator for your money—how it can meet your needs promptly, efficiently and economically.

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Bendix
AVIATION CORPORATION

monitor. The MTS-4 system is engineered to meet adverse military environmental requirements and to prove functionally reliable and easily maintainable. System makes possible the use of c-c tv in military aircraft, ships and vehicles to reliably observe and transmit visual data to one or more monitors. **Circle 203 on Reader Service Card.**

Differentials hollow shaft

FAE INSTRUMENT CORP., 42-61 Hunter St., Long Island City 1, N. Y. A line of hollow shaft miniature precision differentials are engineered for high accuracy in additive and subtractive operations. They have primary applications in angular velocity, sums, differences, sequence and other functions. Some design features include: high speed rotation, minimum backlash and low breakaway torque, and easy installation or removal from a gear train. **Circle 204 on Reader Service Card.**

Sound Level Meter smaller, lighter

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1551-B sound level meter has many new technical features and

improvements over its predecessor. Among these are: a new microphone for better all-round performance; a new meter circuit, which more closely approximates rms response; a new calibration circuit for amplifier gain standardization, which does not require a power-line connection; improved signal-to-noise ratio and dynamic range; improved frequency response. Price is $395. **Circle 205 on Reader Service Card.**

Pulse Height Analyzer single channel

TULLAMORE ELECTRONICS CORP., 6055 South Ashland Ave., Chicago 36, Ill., has available model PHA-2 precision single channel pulse height analyzer for the budget-minded laboratory. It is capable of operating at counting rates in excess of 1,000,000 cpm without appreciable data distortion. Instrument utilizes a window amplifier which has excellent overload characteristics. Input amplitude range normally covered is 0 to 85 v positive. **Circle 206 on Reader Service Card.**

Frequency Converter meets MIL specs

POWER SOURCES, INC., Burlington, Mass. Model PS6001 frequency converter, which meets all requirements of military specifications for ground equipment, has an input of 120 v, 60 cps, and an output of 115 v, 400 cps, 250 w square wave. The converter will operate at any temperature between −30 C and +52 C, and is not damaged by temperature extremes to −65 C and +85 C. **Circle 207 on Reader Service Card.**

Static Inverter transistorized

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J., has developed a static inverter employing a new concept in the conversion of d-c inputs for precision a-c frequencies. It is designed for dependable and accurate power applications for use in driving rate gyros and inertial guidance equipment and other related missile and aircraft uses. The new static inverters are designed to meet military environmental specifications per MIL-E-5272A. They are available with single phase or three phase outputs. **Circle 208 on Reader Service Card.**

Band Pass Filters tunable units

MAURY & ASSOCIATES, 10373 Mills Ave., Montclair, Calif. A new series of narrow band, tunable band pass filters feature miniaturized and ex-

P.S. and don't forget these other quality products at the

BENDIX "SUPERMARKET"

With our greater variety and greater volume of the precision components listed below, we have become the "supermarket" of the industry. We feature fast delivery and mass-production economy—plus the highest precision quality.

400-CYCLE SYNCHROS
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Control Transformers • Differentials • Receivers • Resolvers • Transmitters

GYROS
Directional, Free, Rate, Roll and Vertical Gyro Transmitters • Stable Platforms

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RADAR DEVICES
Airborne Radar Antennae • Ground Antenna Pedestals

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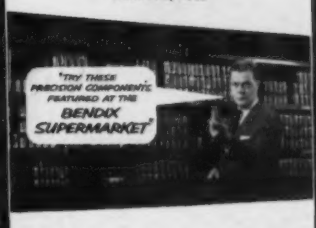
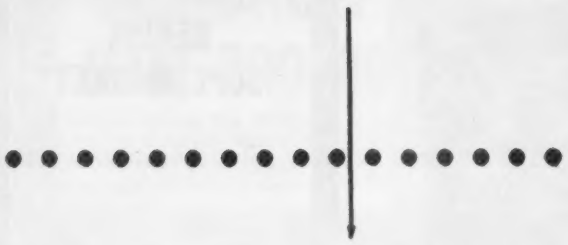


CIRCLE 59 READERS SERVICE CARD



Scientists and engineers at the Los Alamos Scientific Laboratory have access to an unusual variety of research tools: excellent technical libraries, high-speed computers, particle accelerators, experimental reactors, critical assemblies, ultra high-speed cameras, whole-body radiation counters, devices for investigating controlled thermonuclear reactions—and specialized equipment of many other kinds.

The writing and publishing of research papers is encouraged in many ways at Los Alamos. Expert editorial help is available to all staff members. More than 1300 papers have been released for publication and an additional 1700 have been presented at meetings or otherwise made public.

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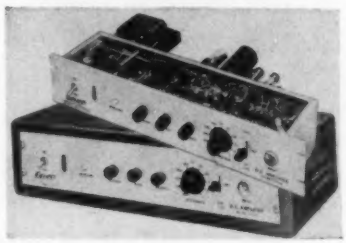
tremely rugged construction, low insertion loss and low vswr. They are ideal for airborne as well as lab type applications. There are four types available when they are cascaded in single to quad units, whioh determines their skirt selectivity. The filters are available at any center frequency from 100 to 2,000 mc. **Circle 209 on Reader Service Card.**

Converters d-c to d-c

SORENSEN & CO. INC., Richards Ave., South Norwalk, Conn., has a new line of transistorized d-c to d-c converters designed for incorporation into a wide variety of battery-powered airborne and mobile electronic equipment. The QC series provide an economical efficient means of obtaining higher voltages from standard 6, 12 or 28-v d-c sources. Standard output voltages range from 50 v d-c (30, on 12-v models) to 1,000 v d-c. Powers to 200 w in 12 v models; to 150 w in 28 v models and to 90 w in 6 v models. **Circle 210 on Reader Service Card.**



D-C Amplifiers for transducers

EDIN, A Division of Epsco, Inc., 207 Main St., Worcester 8, Mass., has available the first two models of a new No. B-series line of amplifiers intended for a wide variety of both rack-panel and portable oscillograph recording needs. Units drift less than 0.5 mw equivalent input per hr

CIRCLE 61 READERS SERVICE CARD→

KL—A VERSATILE, RELIABLE, LOW COST P&B RELAY

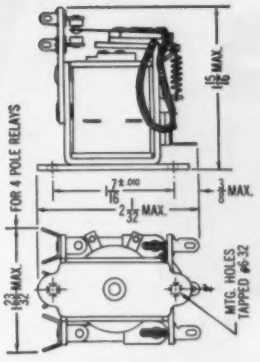
for communications and automation

ECONOMY and versatility distinguish our KL series relays. Contact arrangements are available up to 4 pdt in either AC or DC versions. Sensitivity of 100 milliwatts per movable arm is available.

Stationary contacts and terminals are mounted on a phenolic front of high dielectric strength, thus adding to the utility of the relay. Conveniently located terminals and easy-to-mount base greatly simplify installation on long production runs.

KL relays may be hermetically sealed or furnished in metal dust covers.

This is one of a "family" of fine P&B relays. Others, with similar configurations but various electrical and switching capacities, are shown below. Write or call for more information or see the complete P&B catalog in Sweet's Product Design File.



KL ENGINEERING DATA

GENERAL: Breakdown Voltage: 500 volt rms, 60 cycle between all elements standard 4 pole relay; 1500 volts rms, 60 cycle on special 3 pdt relay.

Temperature Range: −45°C. to +85°C.

Pull-in: Approx. 75% of nominal dc voltage. Approx. 78% of nominal ac voltage.

Terminals: Pierced solder lugs for two #20 AWG wires.

Enclosures: Metal can 2⅝" high x 2⅜" long x 2 11/32" wide with octal plug or multiple solder header.

CONTACTS: Arrangements: up to 4 pdt.

Material: ⅛" dia. gold-flashed silver. (Others available.)

Load: 5 amps @ 115 volts, 60 cycle resistive loads.

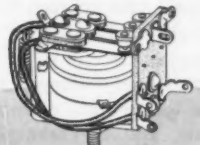
COILS: Resistance: 60,500 ohms max.

Power: 100 milliwatts per movable arm.

Duty: Continuous; coils will withstand 6 watts @ 25°C.

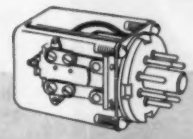
Voltages: up to 110 volts dc. up to 230 volts ac.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



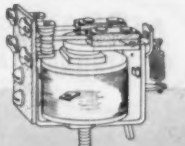
KR SERIES: SMALL, 5 AMP RELAY

Ruggedly constructed for long life and dependability. Available up to 3 pdt.



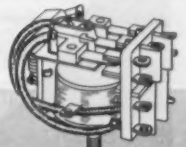
KCP SERIES: SENSITIVE 3 PDT RELAY

For plate circuit applications requiring low cost, sensitive relay. Polyethylene dust cover.



KT SERIES: ANTENNA RELAY

Insulated to minimize RF losses. Designed to switch 500 watts RF input to 300 ohm line.



KA SERIES: GENERAL PURPOSE

Compact, light-duty relay. U/L approved. Meets 1500 volts rms breakdown requirement.

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

THE SPOT LIGHT
is on a new product

AIRPAX
MINIATURE
CIRCUIT
BREAKERS

Power Control and Circuit Protection are provided in this new Airpax Circuit Breaker. Only slightly larger than an "ON-OFF" switch it replaces a switch, fuses and overload relays. Available in ratings from 50 milliamperes to 10 amperes, AC or DC with fast or slow response.

AIRPAX ELECTRONICS INCORPORATED

CAMBRIDGE DIVISION, CAMBRIDGE, MARYLAND

and will operate from 115 v ±5 v power lines without additional regulation. Two meg input impedance plus optional zero suppression allow the unit to be used with a wide variety of transducers. Features include plug-in frequency compensation to extend the range of the galvanometer to 200 cps. **Circle 211 on Reader Service Card.**

Oscillator high stability

MANSON LABORATORIES, INC., 207 Greenwich Ave., Stamford, Conn. Model RD-146, a new version of the RD-140 1-mc high stability oscillator, features a calibrated trimmer control for making accurate frequency adjustments against crystal aging, on a daily, weekly or other frequent time period basis, without comparison to WWV or other standard. Unit features drift rate less than 1 part in 10^8 per day, improved short term stability and lower power consumption. **Circle 212 on Reader Service Card.**

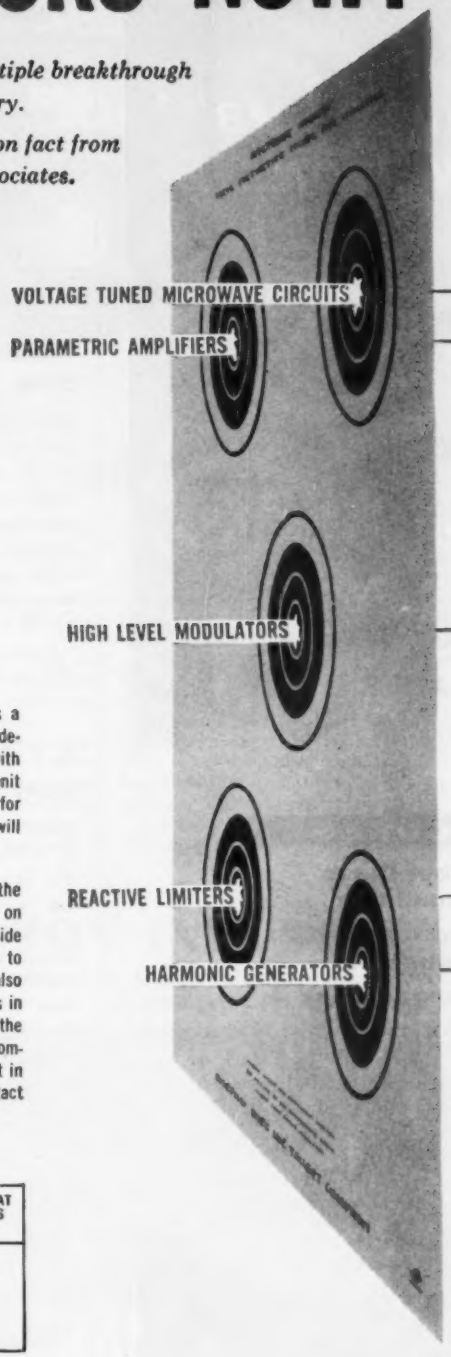
Non-Toxic Resist for p-c production

SCREEN PROCESS LABORATORIES, 5-33 48th Ave., Long Island City 1, N. Y. A new plating and etching resist (No. 1997B) has been developed for the production of printed circuits. It prints easily, and very sharply, with a minimum of drag. It will resist the usual platers cleaning solutions, plating baths and etchants. It is extremely dimensionally stable, expanding about 0.0005 in., com-

VARACTORS NOW!

YESTERDAY . . . *a multiple breakthrough in the laboratory.*

TODAY . . . *a production fact from Microwave Associates.*



This Microwave Associates varactor is a diffused silicon PN junction diode designed to be a variable capacitance with low loss at high frequencies. The unit complies with MIL-E-1 outline 7-1 for cartridge type crystal rectifiers and will fit most standard crystal holders.

In the standard form, the pin end of the diode is connected to P-type material on the top of a small "mesa" and the N-side of the silicon element is connected to the base. Reverse polarity units are also available. Mechanically reversible units in both polarities may be ordered but the single-ended units are generally recommended because they insure placement in holders with the proper end in contact with a heat sink.

TYPE	CUT OFF FREQUENCY (kMc)	CAPACITY AT ZERO BIAS ($\mu\mu$f)
MA-460A	20	8
MA-460B	30	6
MA-460C	40	4
MA-460D	50	4
MA-460E	60	3

VOLTAGE TUNED MICROWAVE CIRCUITS

The high Q of the varactor at microwave frequencies and its voltage variable capacitance provide excellent qualities for use in circuits as AFC, voltage variable filter networks, tuned microwave oscillators.

PARAMETRIC AMPLIFIERS

The varactor used in very simple circuits requiring no refrigeration has demonstrated low noise, high gain performance from 1 to 6000 mc. Noise figures of approximately 1 db at UHF and 5 db at 6000 mc. are typical. We believe the varactor will be the component of choice for receiver inputs from 30 to 6000 mc.

HIGH-LEVEL MODULATORS

For the difficult problem of imposing VHF and UHF intelligence on a microwave carrier, the varactor is a top performer. The varactor accomplishes the mixing function with signal gain in the side bands as opposed to present low efficiency techniques.

REACTIVE LIMITERS

The varactor has been used as a passive reactive limiter at UHF frequencies. It is believed that the varactor will be an ideal "receiver protector" as an adjunct to present UHF radar duplexing systems.

HARMONIC GENERATOR

The unique properties of the varactor provide highly efficient harmonic generation. Useful harmonics have been generated up to 100 kMc. With inputs at HF, VHF, UHF and lower microwave frequencies, conversion losses of considerably less than 1 db per harmonic have been observed. The varactor driven by transistor or tube oscillators appears very promising as a signal source in the microwave region.

Send for catalog 59V

MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASSACHUSETTS • Telephone: Browning 2-3000

New availability in skin sizes, cores and adhesive materials now make wider range of honeycomb sandwich combinations possible for the electronics engineer.

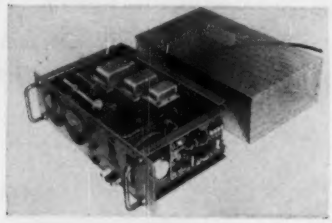
SKINS	CORES
Aluminum	Fiber Glass
Magnesium	Aluminum
Titanium	Impregnated Paper
Stainless Steel	Asbestos
Carbon Steel	Canvas Duck
Fiber Glass	

Chances are one of the above sandwich combinations will answer your electronic housing problem relative to: minimum of weight, rigidity, thermal conductivity, vibration damping, fatigue resistance, radio frequency, dielectric barriers or "U" factor.

To that end, merely forward us a schedule of the environmental conditions, and we will, without obligation, make a recommendation. For further details write or wire:

albano co. inc.

pared to the usual 0.005 in. No strong solvents are necessary to clean screens, as they can be cleaned with ordinary mineral spirits. **Circle 213 on Reader Service Card.**



Power Supplies
close regulation

ELECTRONIC RESEARCH ASSOCIATES, INC., 67 Factory Place, Cedar Grove, N. J., announces new additions to their line of Magitran high current regulated power supplies which combine the characteristics of magnetic and transistor regulators. The new units provide regulated output in the range 0-36 v d-c with current ratings up to 20 amperes. **Circle 214 on Reader Service Card.**

X-Y Indicator
many applications

TECHNITROL ENGINEERING CO., 1952 E. Allegheny Ave., Philadelphia 34, Pa. Model 1002 cathode ray indicator provides a visual indicating device for the dynamic display of electrical signals. It is intended primarily as an output indicating device for such instruments as the Technitrol dynamic diode tester and transistor curve tracers, no internal sweep circuits being provided. Price is $375. **Circle 215 on Reader Service Card.**

Precision Pots
high temperature

DAYSTROM PACIFIC, 9320 Lincoln Blvd., Los Angeles 45, Calif. Model 313, first of a new series of high

FASTEST TUNING PULSE MAGNETRON TUNES HYDRAULICALLY

adapts to current systems

This is the first public announcement of the first hydraulically-tuned pulse magnetron. It permits a powerful new capability in anti-jamming pulse-to-pulse frequency diversity operation.

Designated L-3211 and equipped with an hydraulic tuning actuator we developed, *this is the fastest tuning, medium power magnetron in production today.*

The L-3211 is designed for X-band operation with electrical characteristics similar to those of our standard field-proved 6543 magnetron. The principles of its design make it adaptable to other power levels and frequency bands.

Tubes of this family greatly enhance system tuning capability, approaching that of voltage-tuned tubes, with much greater efficiency and less system complexity. The L-3211 affords a means of upgrading both new and existing radar systems in operational effectiveness. (We also can provide information on a "need-to-know" basis on classified tubes that have even greater capabilities than the L-3211.)

In constructing the L-3211 we use certain techniques proprietary with us... techniques which guarantee a long operating life and a long shelf life. Ageing-in prior to full-power operation is unnecessary.

It is another one of a large number of microwave tubes used in radar and countermeasures built to specifications established by Litton Industries . . . specifications which have become recognized as standards by the military services.

Our Applications Engineering Lab is well equipped* to analyze your problem. It has been remarkably successful in finding fast and accurate solutions to difficult system problems. Let it solve yours. We'll be glad to answer your specific inquiries, or to send you a copy of our catalog. Litton Industries Electron Tube Division, Office E8, 960 Industrial Road, San Carlos, California.

*Incidentally, so is our Personnel Department.

LITTON INDUSTRIES Electron Tube Division

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KLYSTRONS • BACKWARD WAVE OSCILLATORS • NOISE SOURCES • DISPLAY TUBES

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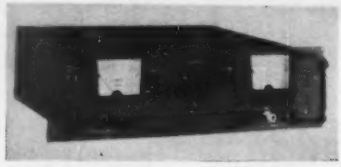
temperature precision units, is available in resistance values from 10 ohms to 50 K ± 5 percent. Operating temperatures of the miniature 1.5 w pot range from −55 to +200 C. One watt is dissipated at +95 C. The unit also meets or exceeds MIL-STD-202 Method 202 shock and vibration and NAS 710 noise specifications. **Circle 216 on Reader Service Card.**

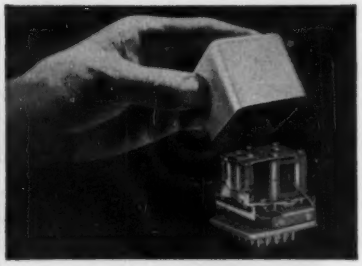


Power Supply
over-load protected

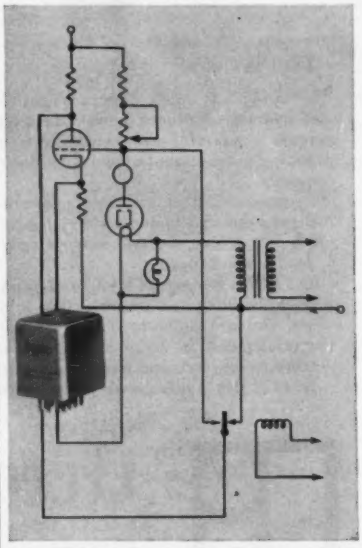
MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J. A new transistor power supply features stable output voltages from 0 to 36 v d-c at 5 amperes continuous duty. Line and load regulation is better than 0.1 percent and output can be limited to any value from 0 to 5 amperes through a front panel selector. Overshoot is not measurable, thus insuring instantaneous protection to rated components and external circuitry. **Circle 217 on Reader Service Card.**

Connector Parts
machined Teflon

TRI-POINT PLASTICS, INC., 177 I.U. Willets Rd., Albertson, N. Y. Self-sealing action, size reduction, dependability at high temperatures and under submersion in corrosive missile fuels are features of the insulating parts used in aircraft connectors illustrated. Tri-Point's



REGOHM
voltage regulation down to ±0.05%
EXTENDS TUBE LIFE



The sensitive yet rugged REGOHM controls input voltage to eliminate the power-source variations which cause premature tube failure. Automatic and precise, this plug-in unit assures constant voltage input.

More and more designers are including REGOHM in circuits, because of its:

- STEPLESS CONTINUOUS CONTROL
- WIDE FREQUENCY RANGE
- PERMANENT ADJUSTMENT
- FREEDOM FROM MAINTENANCE
- RUGGED DESIGN
- LIGHT WEIGHT
- LONG LIFE • LOW COST

Design data, performance specs and case histories of those applications you wish to explore will be sent on request.

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ELECTRIC REGULATOR CORPORATION
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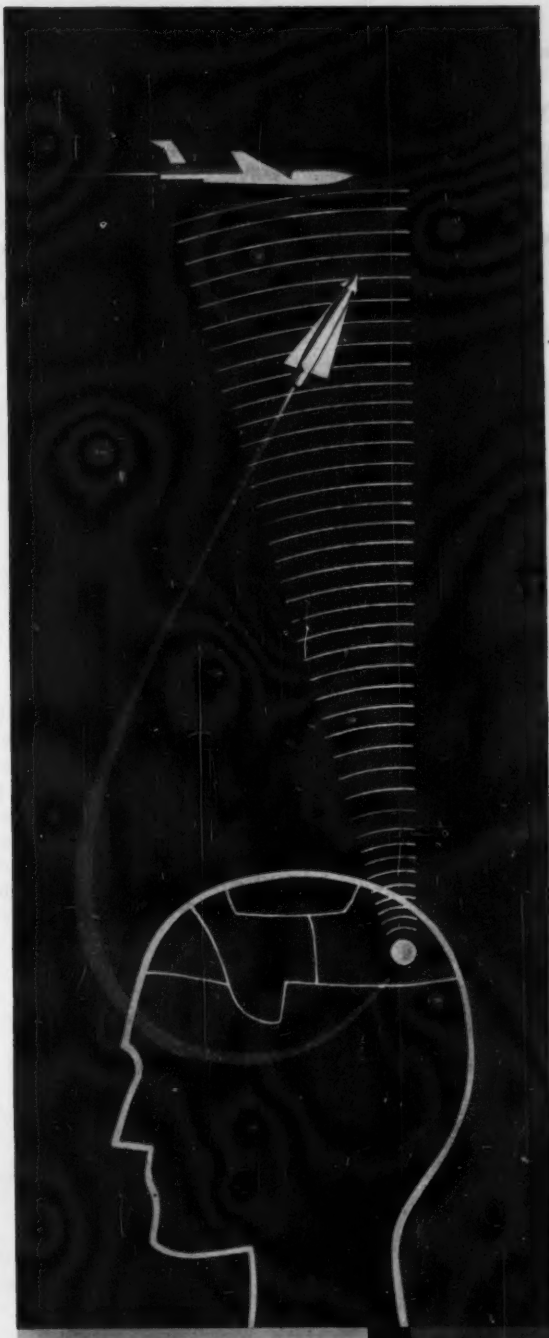


From Bell Telephone Laboratories...

Brainpower
for the brawny
Nike-Hercules

The Army's newest surface-to-air guided missile—the lethal Nike-Hercules—is now operational. Because it is, no unfriendly plane will be able to fly sufficiently high, fast or evasively to escape a fatal rendezvous with it.

For Hercules has a "brain"—an intellect that makes it a prodigy among today's electronic robots. Bell Telephone Laboratories developed it. Western Electric (prime contractor for the entire missile system) is producing it. Douglas Aircraft Company is giving it its body.

This "brain" is a fully integrated guidance system, almost entirely land-based. Only the vital signal-receiving apparatus is expendable within the missile itself. Other highly practical features: it defies "jamming," is completely mobile, is designed in separate "building block" units which are replaceable in seconds—and is deadly accurate.

Bell Labs scientists and engineers designed the world's largest and most intricate telephone communications network for the Bell System. They developed about half of the Armed Forces' radar equipment during World War II. And they pioneered the nation's *first* successful air defense guided missile system—Nike-Ajax.

They were eminently qualified to give Hercules the brainpower it needed.

BELL TELEPHONE LABORATORIES
World center of communications research and development

Vigilant acquisition radar for Nike-Hercules first detects approach of distant aircraft, pinpoints its location and instantly signals to battery control.

Two tracking-radar antennas, housed in radomes, take over. One feeds target azimuth, elevation, range data to computers; other tracks Hercules.

Two sets of radar data are electronically computed and plotted. Hercules is "steered" by radio signals, then detonated at precise point of interception.

CURTISS WRIGHT

CUSTOM DESIGNED
ELECTRONIC COMPONENTS

TIME DELAY RELAYS
Instant reset — Voltage compensated

Curtiss-Wright "IR" thermal time delay relays reset the instant they are de-energized. The second cycle will always provide the same delay as the first cycle. Variations from 22 to 32 volts will not affect the time delay of the "IR" Series.

SPECIFICATIONS

Time delay.....Preset 20 to 180 seconds
Contact arrangement..SPST, DPDT OR SPDT
Temperature comp.....−65°C to +125°C
Weight:.....4½ ounces
Terminals.....Hooked solder type
Mounting.....Bracket or stud
Variations of the above relay characteristics available upon request.

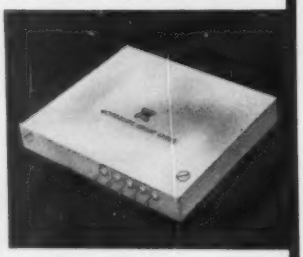
New DIGITAL MOTORS

Stepping motors for high reliability applications. Meet the requirements of assured reliability and long life for aircraft, missile and automation systems.

FEATURES | Bi-directional • Positive lock • Dynamically balanced • Simplicity of design • High pulsing rate.

New ULTRASONIC DELAY LINES

Enables development engineers to employ new concepts in existing and projected applications. Low in cost, small in size and simple to operate.



SPECIFICATIONS

Delay range.....5 to 6000 microseconds
Tolerance.....± 0.1 microsecond
Signal to noise ratio.....Greater than 10:1
Input and output impedance.50 to 2000 ohms
Carrier frequency.....100 kc — 1 mc
Delay to pulse rise time.....Up to 800:1

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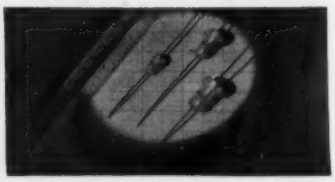
ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • WEST CALDWELL, N. J.

components are machined from Teflon resin. A special, high-density TSI resin stock is used, with tolerances on some parts kept to 0.001 in. and less to attain the connector performance required. (Tri-Point parts are used in aircraft connectors shown on p 98 and made by Titeflex, Inc., Springfield, Mass.) **Circle 218 on Reader Service Card.**

P-M Motor high temperature

JOHN OSTER MFG. CO., 1 Main St., Racine, Wisc., offers a new high temperature ±3 percent speed regulation continuous duty 1¼ in. p-m governed motor with gear reduction and filter. It features 60 oz in. load and 24 to 29 v d-c supplied under MIL-E-5272 environmental conditions. **Circle 219 on Reader Service Card.**



Tantalum Capacitor shock resistant

FANSTEEL METALLURGICAL CORP., North Chicago, Ill. The PP type tantalum capacitor has been further improved by a specially designed anode base support which gives it exceptional resistance to shock and vibration. Unit is electrically stable over a wide range of operating temperatures—from −55 C to 85 C. It also exhibits outstanding frequency stability and negligible electrical leakage. Type PP consists of a sintered porous tantalum anode, hermetically sealed in a fine silver case which serves as cathode and con-

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- STABLE AT HIGH TEMPERATURES

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Thermoplastic insulation type MW 1000 volt—80°C, military specifications Mil-W-76A. In 30 color combinations. Fungus-proof. Resistant to acids, alkalis, oil, flame and moisture.

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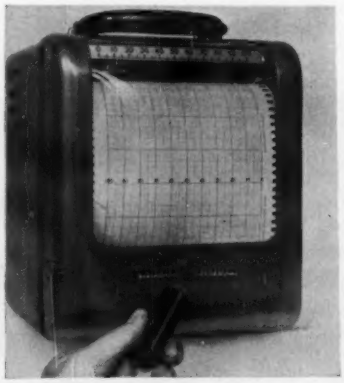
tainer for the electrolyte. The tantalum oxide film which forms on the anode is said to be the most stable dielectric known. **Circle 220 on Reader Service Card.**

Regulator Tubes
corona type

THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio, has developed the M-42 miniaturized high voltage corona type regulator tubes in metal enclosures for operation at voltages from 3 kv to 12 kv. They are ideally suited for the regulation of power supplies for airborne radar due to their small size, light weight, rugged construction and ability to withstand a wide range of ambient temperatures. **Circle 221 on Reader Service Card.**



Strip-Chart Recorder
multirange

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif., announces a 5-in. strip-chart temperature recorder with a variety of ranges provided by easily changed plug-in elements. These match appropriate thermocouples. Automatic reference

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NOW, FROM GENERAL ELECTRIC'S NEW 6L6-GC...

Power

55 WATTS...with only 2% distortion without feedback*

Power for orchestral climaxes with full concert-hall brilliance . . . yet mellow in tone, undistorted! You can build this high speaker power into your new equipment at a cost *one-third less* than the cost of other tubes with comparable performance!

With 30 watts plate dissipation, 5 watts screen, General Electric's 6L6-GC beam pentode can take peak power demands in stride. This is a new tube throughout, designed to handle easily the speaker requirements of the finest audio systems. Type 6L6-GC has, among other features:

- Special 5-layer bonded-metal plate, developed by General Electric for improved heat conduction and radiation.
- New large heat radiator on control grid, to minimize grid emission.
- Redesigned screen grid, for higher dissipation.
- New protective slots on micas, to reduce high-voltage interelement leakage.
- New-design bulb, to radiate heat more efficiently.

Top power output—low distortion—completely new design—economy! Four important advantages to *you* of General Electric's 6L6-GC. Ask any G-E Receiving Tube Department office below for further information!

*** Two 6L6-GC tubes push-pull, Class AB_1 service, with 450 v on the plate.**

Key design-max ratings, per tube, of the new General Electric 6L6-GC are:

Plate voltage	500 v
Plate dissipation	30 w
Screen voltage	450 v (500 v center tap)
Screen dissipation	5 w
Cathode current	110 ma

200 Main Avenue, Clifton, New Jersey
(Clifton) GRegory 3-6387
(N.Y.C.) Wisconsin 7-4065, 6, 7, 8

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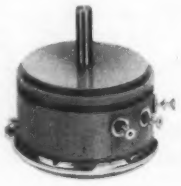
you'll need help!

If you earnestly feel the only way to get the kind of pots you need is to build 'em yourself — a word of caution. Don't start off alone — gather a few choice friends around to assist with the problems you might run into. There's the little matter of metals engineering, plastics, contact engineering, chemical, metallurgy and other assorted engineering areas. Otherwise, you might *never* get through all these little details!

But don't waste time putting your friends through engineering school — Ace has a staff of specialists and consultants all recruited for just such design problems! They save us — and in turn — our customers, needless concern over the stumbling blocks which may arise. So if a unique design solution to your pot requirements is what you're after, don't hesitate! See your ACErep!



Here's a typical bit of ACE collaboration: Our A.I.A. 1-1/16" size ACEPOT®, servo-mount.

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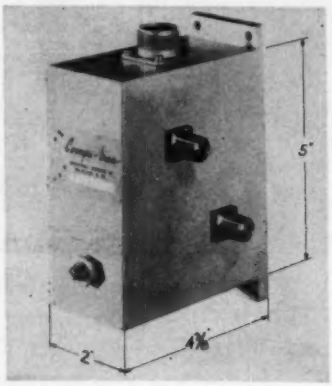
SOmerset 6-5130 TMX SMVL 181 West. Union WUX

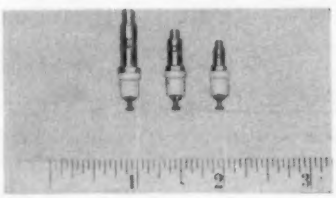
Acepot® Acetrim® Aceset® Aceohm® *Reg. Appl. for

junction compensation eliminates need for external temperature reference. Typical spans are −150 to +250 F, 0 to 400 F, 0 to 2,200 F and many others. **Circle 222 on Reader Service Card.**



Pressure Transmitter shock resistant

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa., has announced a new COMPU-TRAN zero setting differential pressure transmitter. Model 70-2900 features 0.2 percent measurement accuracy, infinite resolution, and zero output preset at any point throughout the range. The shock resistant unit is suitable for corrosive atmospheres and is available in static pressure ranges from 0-100 to 0-3,000 psi with differentials up to 100 percent of range. **Circle 223 on Reader Service Card.**



Diode Clips spring loaded

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., has added three new spring loaded Teflon-insulated diode clips to its Cambion line. All three are feed

(Continued on p 108)

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For full information, write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Massachusetts.

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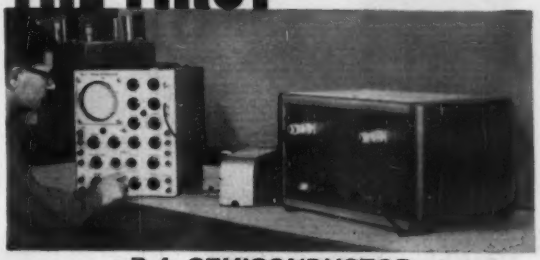

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Baird-Atomic Model JJ a basic tool for the

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Range: MCL above 10 microseconds

Accuracy: ± 10%

Method: conductivity modulation

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Baird-Atomic, Inc.

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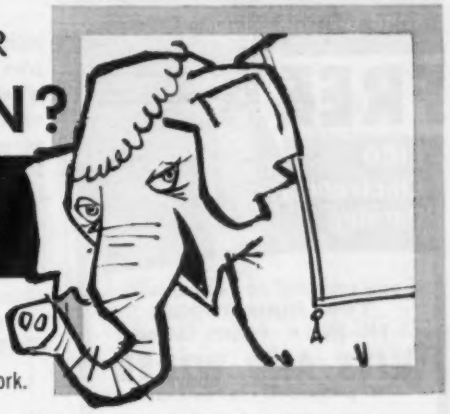
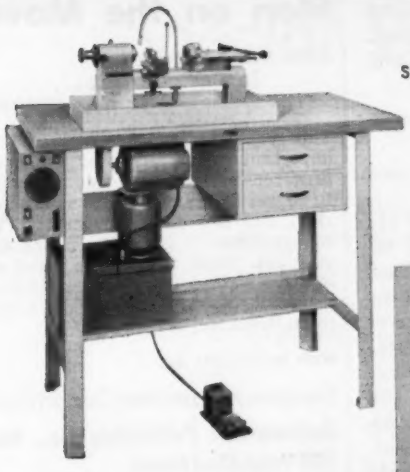


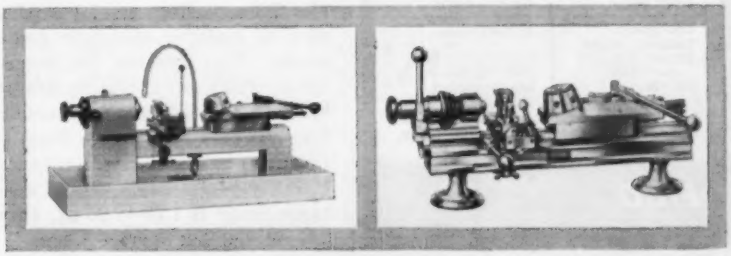
LEVIN® TURRET LATHES PRODUCE SMALL INSTRUMENT PARTS BETTER



A complete Turret Lathe for small parts. Particularly useful for second operation work. Maximum collet capacity 5/16". Standard models provided with self indexing, six position turret, collet closer, double tool cross slide and variable speed control.

For full details of Turret Lathes and other Instrument Lathes send for catalog T.

Louis Levin & Son, Inc., 3610 So. Broadway, Los Angeles 7, Calif.



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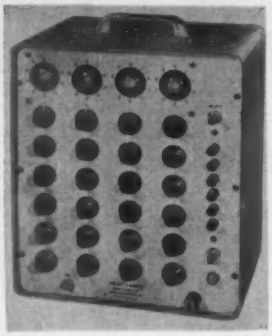
throughs designed to press mount into 0.205 in. diameter holes in terminal boards. The Teflon overlaps at top and bottom, thus securely mounting the clip while insulating it. Processed from quality brass, the clips are finished in a durable electro-plate. **Circle 224 on Reader Service Card.**



Preset Counter high speed

FREED TRANSFORMER CO., INC., 1722 Weirfield St., Brooklyn 27, N. Y. Type 2020-4-6 multiple preset counter was designed and developed for counting and sequential predetermining control applications. It is ideally suited for applications when a machine or a process is started manually and stops automatically at several preset counts in one operation. For example, one of the vital industrial operations to which the counter can be applied is the winding of tapped toroidal or transformer coils. Unit performs this and scores of similar complex operations accurately and at great speed. **Circle 225 on Reader Service Card.**

Capacitors tantalum slug

OHMITE MFG. CO., 3693 Howard St., Skokie, Ill. Tan-O-Mite brand, series TS capacitors employ a porous slug of sintered tantalum for the anode. They feature the extraordinary shelf and operating life, stability and wide operating temperature range which derive from the inertness of tantalum metal and the stability of its oxide film. Capacitance range is 1.75 to 30 μf. **Circle 226 on Reader Service Card.**

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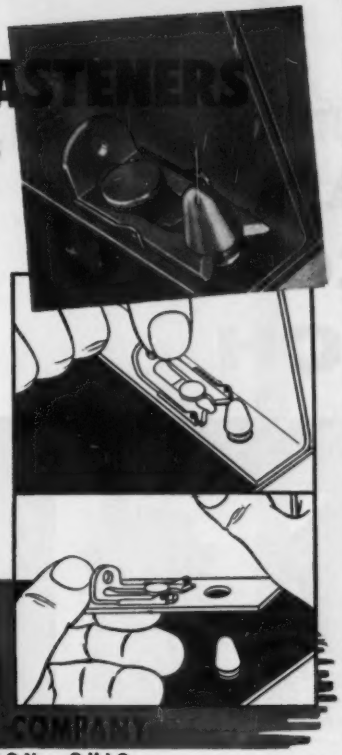

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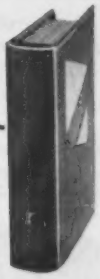
Just Published—A comprehensive picture of the principles behind computing machines in use today. Shows how basic circuits and devices are assembled and interconnected to form the main units of a computer. Includes practical information on digital-computer arithmetic, general considerations of systems, static and dynamic cells, large-scale memory devices, shifting registers, adders, accumulators, etc. **By Charles V. L. Smith, Chief, Computing Lab., Aberdeen Proving Grounds. 443 pp., illus., $12.00.**



ELECTRONIC SEMICONDUCTORS

A rigorous and systematic introduction to semiconductor physics as related to rectifier and transistor problems. Explains the subject in a logical and consistent manner from simple concepts, and gives a clear understanding of the conduction mechanism of electronic semiconductors within the framework of the band model. **By E. Spenke. Translated by D. Jenny, H. Kroemer, E. G. Ramberg, and A. H. Sommer, RCA Labs, Princeton, N J. 430 pp., 163 illus., $11.00.**

CONTROL ENGINEERING MANUAL

Covering control systems engineering in both industry and the military, this book brings you the latest facts, methods, and engineering know-how from the nation's leading specialists in the field. Helps you analyze tentative control system configurations by means of mathematical, trial and error, computer and graphical techniques. **Edited by Byron K. Ledgerwood, Mng. Ed., Control Engineering. 185 pp., 200 illus., $7.50.**

INDUSTRIAL ELECTRONICS HANDBOOK

Just Published—Over 100 experts supply authoritative descriptive and reference material on all phases of industrial electronics and control. Concise and practical, this handbook covers basic engineering and mathematics, physical laws, control elements, power supplies, control circuits, circuit applications, mechanical design, ultimate utilization requirements, and technical information sources. **Prepared by a Staff of Specialists. Edited by W. D. Cockrell, General Electric Co. 1408 pp., illus., $22.50.**

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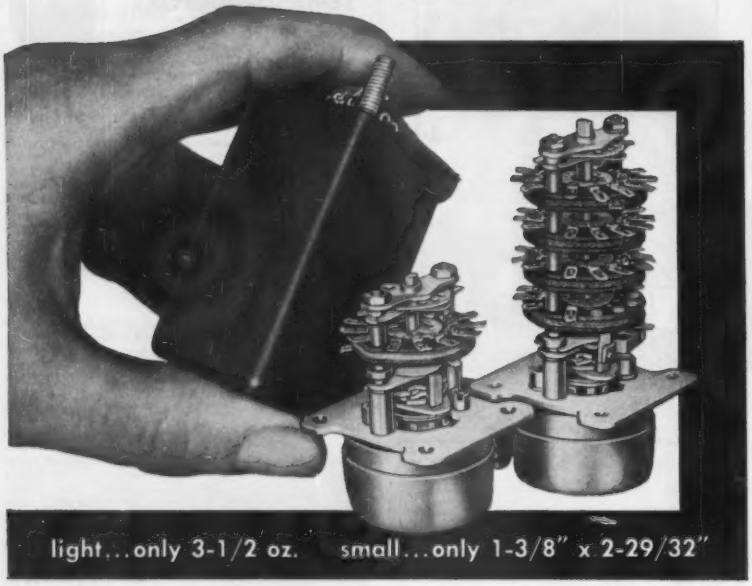

These circuit selectors or stepping relays, model BD2, perform dependable, remote switching jobs such as, stepping . . . counting . . . programming . . . circuit selecting . . . sequencing . . . and homing.

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Immediate delivery from stock of standard model, part No. S-10019-004 . . . 3 pole, 12 throw switching, 12 position, notch homing, self-interrupted, 28 volts D.C., flange mounting

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N.S.F. GmbH, Further Strasse 101a, Nurnberg, Germany

Literature of

MATERIALS

Platinum Metals. J. Bishop & Co. Platinum Works, Malvern, Pa. *Platinum Metals Review* is a 40-page quarterly publication devoted to research of the platinum metals and their applications in industry. It can be obtained without cost by writing on company letterhead.

Ferromagnetic Materials. The Polymer Corp. of Penna., 2140 Fairmont Ave., Reading, Pa. A new 4-page bulletin is available on Ferrotron ferromagnetic materials, a line of non-memory, inductive electromagnetic core components. **Circle 230 on Reader Service Card.**

Phenolic Products. General Electric Co., Pittsfield, Mass. A new, 8-page, illustrated brochure describes the company's complete line of phenolic resins, varnishes and molding powders. **Circle 231 on Reader Service Card.**

COMPONENTS

Magnetic Amplifiers. Brach Mfg. Corp., 200 Central Ave., Newark 3, N. J., has available a 12-page brochure describing expanded facilities for the manufacture of magnetic amplifiers and saturable reactors, including associated circuitry and equipment. **Circle 232 on Reader Service Card.**

Silicon Rectifiers. Sarkes Tarzian, Inc., Bloomington, Ind. Catalog No. 69 is a 46-page handbook containing descriptive information and technical data on a wide line of silicon rectifiers. **Circle 233 on Reader Service Card.**

EQUIPMENT

Adjustable-Speed Drives. Servo-Tek Products Co., 1086 Goffle Road, Hawthorne, N. J. Catalog 11058 is a 16-page compilation of technical data including a discussion of the basic methods for op-

the week

erating d-c motors from a-c power sources. **Circle 234 on Reader Service Card.**

Low-Level Amplifiers. Epsco, Inc., 588 Commonwealth Ave., Boston, Mass. A recent brochure covers low-level wide-band differential d-c amplifiers. The various options available on the instruments are described. **Circle 235 on Reader Service Card.**

Dynamic Memory Processor. Genesys Corp., 10131 National Blvd., Los Angeles 34, Calif. Bulletin DDMP-1 illustrates and describes the company's dynamic disk memory processor, a system nucleus product applicable to many data handling and control computing applications. **Circle 236 on Reader Service Card.**

Memory System. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa. Technical bulletin 58-B describes model 3122 random access store which features an apertured ferrite plate as the storage medium. **Circle 237 on Reader Service Card.**

Magnetic Tape Tester. General Kinetics Inc., 555 23rd St., South, Arlington 2, Va., has available a bulletin describing a new digital computer accessory, the model U-1 automatic magnetic tape tester. **Circle 238 on Reader Service Card.**

FACILITIES

Potentiometer Definitions. Clarostat Mfg. Co., Inc., Dover, N. H., has published a brochure entitled "Potentiometer Definitions." It lists functional definitions as a guide to users of the company's products. **Circle 239 on Reader Service Card.**

Military Facilities. Singer Mfg. Co., 149 Broadway, New York 6, N. Y., describes its facilities for service to the Armed Forces and their prime contractors in a new four-color, 28-page booklet. **Circle 240 on Reader Service Card.**

Accurate

*These tolerances are from absolute frequency under any combination of the conditions within operating specifications. For specific operating conditions much closer frequency tolerances may be maintained.

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FREQUENCY STANDARDS

TYPE MAFC — Frequency Standard
- Frequency Range Available: 360 cps to 4 kc
- Tolerances % ±: 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Ranges: —20 to +71°C, —55 to +100°C, —55 to +125°C
- Power Supply Voltage: 12 or 28 vdc ± 15%
- Size: 1⅜"x1⅜"x2¼" • Weight: 8 oz.

TYPE AFC — Frequency Standard
- Frequency Range Available: 360 cps to 4 kc
- Tolerances % ±: 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Ranges: —20 to +71°C, —55 to +100°C, —55 to +125°C
- Power Supply Voltage: 12 or 28 vdc ± 15%
- Size: 2⅛"x2⅛"x3¼" • Weight: 13 oz.

TYPE MAFCD — Frequency Standard
- Frequency: 60 cps
- Tolerances % ±: 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Range: —55 to +71°C
- Wave Shape: Sine w/less than 1% harmonic distortion
- Power Supply Voltage: 10 to 14 vdc
- Size: 4⅛"x4⅛"x4⅛" • Weight: 4 lbs.

TYPE MFB — Frequency Divider
- Ratios Available: 2:1, 4:1, 5:1, 8:1, 10:1, 16:1
- Temperature Ranges: —20 to +71°C, —55 to +100°C
- Power Supply Voltage: 12 or 28 vdc ± 15%
- Size: 1⅜"x1⅜"x2¼" • Weight: 6 oz.

TYPE MFS — Frequency Standard for Laboratory or Field

Type MFS is a small, lightweight frequency standard that can replace units many times its size without sacrificing frequency stability. Internal batteries and provisions for external power supply make the unit ideal for either laboratory or field applications.
- Frequency Ranges Available: 50 cps to 4 kc
- Frequency Stability: 2 parts in 10^9/per month
- Temperature Range: —20 to +71°C
- Size: 3⅞"x5⅝"x5⅝" • Weight: 2 lbs.

TYPE MLS — Laboratory — Frequency Standard

Type MLS is an extremely high stability laboratory frequency standard. The clock on the panel facilitates easy checking of stability.
- Frequency Ranges Available: 50 cps to 4 kc (Multiple Taps Optional)
- Frequency Stability Available: 5 parts in 10^7
- Output: 10 watts at specified frequency
- Input: 115 v, 50 cycles to 400 cycles
- Size: 9"x10"x7" • Weight: 15 lbs.

A wide variety of units are designed to comply with the most severe military specifications.

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ACCURATE INSTRUMENT CO.

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JA 3-2712

Erecting Microwave Plant

CONSTRUCTION has begun on a new 40,000 sq ft, one-story plant in Clifton, N. J., for the John Gombos Co., Inc., manufacturer of microwave equipment and mechanical and electromechanical assemblies.

Located on a four-acre plot which allows for additional expansion, the plant will almost double manufacturing and assembly space, and will include very modern aluminum dip-brazing facilities, according to John Gombos, president. The plant will be within one-half mile of several major New Jersey highways and 15 minutes from midtown New York.

Gombos says the company plans to substantially expand its engineering department. Company has already purchased many new machine tools which will be moved to the new plant. Gold, silver, chrome, nickel and copper plating facilities will be included.

New building is scheduled for completion in near future and will accommodate approximately 300 employees on a one-shift basis. The company now has about 150 employees in its Irvington, N. J., plant. All operations will be moved to Clifton when the new plant is ready.

Galbraith Takes New Post

EXECUTIVE vice-president Vess Chigas of Microwave Associates, Inc., Burlington, Mass., appoints James S. Galbraith as manager of semiconductor operations. In this capacity, Galbraith will report directly to Chigas.

Galbraith will be responsible for the coordination of all semiconductor operations at Microwave Associates, including research and development, engineering, and production. He was formerly sales manager for semiconductor products at Microwave.

For seven years prior to his affiliation with Microwave in 1958, Galbraith was with Sprague Electric Co. in North Adams, Mass.

Establish New Company

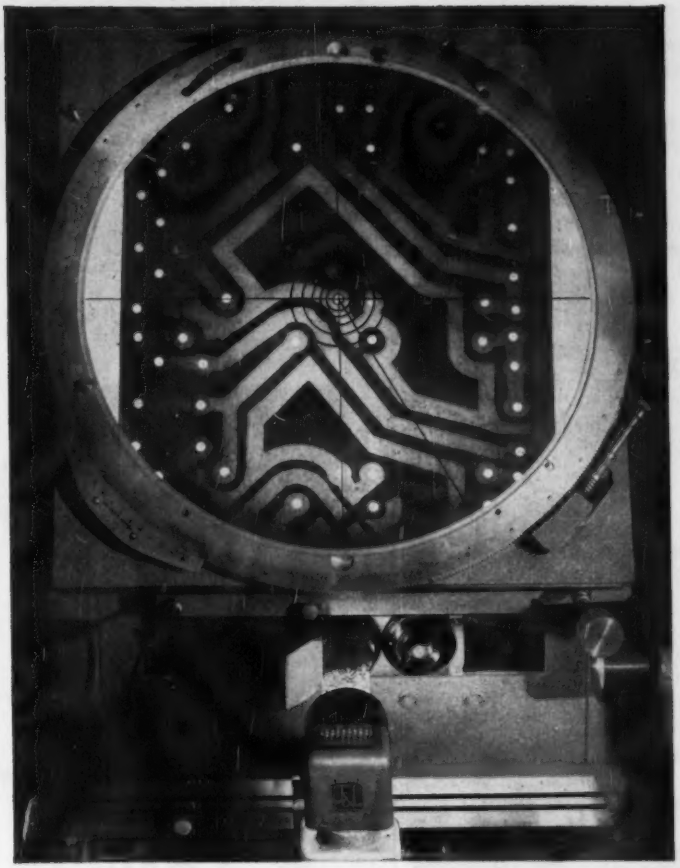
FORMATION of Edal Industries, Inc., New Haven, Conn., is announced. Company will manufacture a stabilized instrument rectifier, copper oxide and selenium diodes, selenium rectifiers, diode modulators, demodulators, phase comparators and varistors.

IBM Promotes A. G. Anderson

WITH the IBM Watson Research Laboratory, San Jose, Calif., since 1953, Arthur G. Anderson was recently appointed acting manager of basic science there. He will be responsible for fundamental research which becomes the basis for new technology which ultimately results in significant new computer concepts.

Yarbrough Joins Gabriel Division

APPOINTMENT of Stanton L. Yarbrough as vice president of the electronics division of The Gabriel Co. is announced. Located in Needham Heights, Mass., this division produces antennas, microwave sys-



J & L Comparators are ideally suited for inspection of printed circuits — because they provide coordinate measuring facilities corresponding to the method by which circuits are dimensioned.

In mating the printed circuit with other components, it is necessary that the terminal points be located accurately. Also — to assure a uniform flow of current through the connectors, the drilled holes at the terminals must be centralized within the circuitry.

A Comparator, equipped with a surface illuminator, projects a reflected image to a chart having radii and lines. By comparing the image of the drilled holes to the radii on the chart the size and location of the holes may be determined.

True precision like this never comes cheap!

Of all the possible areas in which to economize, quality inspection is the least promising. Why?

Simply because the kind of intensive research, painstaking engineering and top-quality manufacture it takes to produce precision inspection equipment like the J&L Comparator just CAN'T be offered at bargain-basement prices. On the other hand, cheap equipment doesn't belong in the same league with a J&L Comparator when it comes to accuracy, speed, versatility and all-round dependability. When it comes to true precision of inspection, a cheap comparator can prove to be *terribly* expensive.

J&L Comparators come in 11 models, both bench and pedestal type.

"The originator of machine tool standards in optical inspection"

JONES & LAMSON

JONES & LAMSON MACHINE COMPANY, Dept. 710, 539 Clinton Street, Springfield, Vt., U.S.A.
Please send me Comparator Catalog 5700, which describes the complete line of J&L Optical Comparators.

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company _____

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Model FC-30

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212 Broad Street, Lynn, Massachusetts

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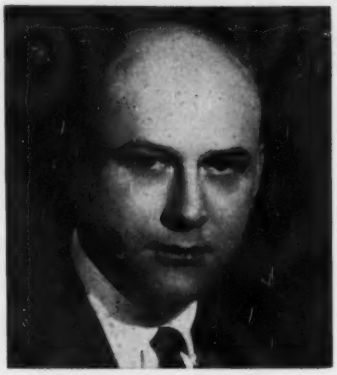
tems and electronic countermeasure components used extensively by the aircraft and missile industries.

Prior to his new association with Gabriel, Yarbrough served in various executive capacities with several leading corporations, including the Remington Rand division of the Sperry Rand Corp., the Philco Corp. and the Rheem Mfg. Co.



Wolf Takes New Stavid Post

B. H WOLF has been appointed Air Force Contract Manager for Stavid Engineering, Inc., Plainfield, N. J. He was formerly manager of the airborne electronics department. In his new assignment he will be responsible for pre-contract planning in connection with Stavid's Air Force programs.

Since joining Stavid in 1949, Wolf has directed various development programs including airborne bombing radars, beacons, search-track equipment and radar fire control systems.

News of Reps

The **Richard Capell Co.** is named sales rep for southern California and Arizona by Hi-Spec Electronics, North Hollywood, Calif., manufacturer of miniature sensitive relays.

Five new manufacturer sales reps are appointed to handle the products of the Staver Co., Inc., Bay

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No. 241 HAND
NOTCHER

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7 LBS.

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16 Ga. Mild Steel

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Useful for a lot of different notching operations, as shown by examples of side, corner, and flange cuts. Very efficient on corner moulding, also shallow sheet metal channels. The curved blade hooks to a point that will engage a punch prick for exact location of notch.

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for severe conditions
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molded Black Nylon
SCREWS and NUTS
★ Acid resistant
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★ Can't rust
★ Can't corrode

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Shore, L. I., N. Y. New reps and the territories they cover are:

J. H. Paterson of Akron, Ohio, for the state of Ohio; **Herb Mandell** of Revere, Mass., for Connecticut, Maine, Rhode Island, New Hampshire, Vermont and Masachusetts; **Leemark Associates** of Kansas City and St. Louis, Mo., for Kansas, Nebraska, Missouri, Colorado, southern Iowa and E. St. Louis, Illinois; **Jack Geartner** of Miami Beach, Fla., for the state of Florida; **Murphy & Cota** of Atlanta, Ga., and Charlotte, N. C., for North and South Carolina, Alabama, Mississippi and Tennessee.

Scientific Sales Engineering Co., with offices in Atlanta, Ga., and St. Petersburg, Fla., has opened a new Winston-Salem branch office. Firm represents several electronic instrument and component manufacturers in the southeastern states and specializes in precision components and application and engineering services.

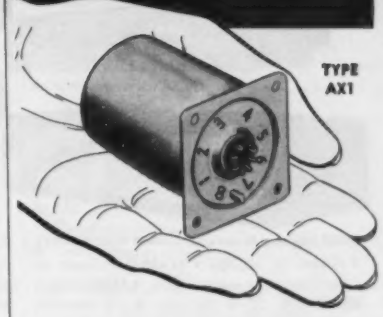
Penta Laboratories, Inc., Santa Barbara, Calif., appoints **J. L. Peirce Co.**, of Detroit, as representative in the state of Michigan.

Ferroran Electronics Co., Inc., New York, N. Y., appoints **Featherstone & Salisbury Co.** of San Francisco, Calif., as manufacturer's rep for northern California and northern Nevada to handle the sale of its line of transistor equipment and components, miniature rectifier and audio transformers, and miniature semiconductor power supplies.

Schaevitz Engineering, Pennsauken, N. J., manufacturer of electronic components, announces three new sales reps:

Testco of Seattle, Wash., will represent it in Washington, Oregon, Idaho and Montana. **Ensco** (Engineering Service Co.) of Kansas City, Mo., will handle the Missouri, Kansas, Iowa and Nebraska area. **Southwest Electronic Industries** of Dallas, Texas, will cover Texas, except El Paso, as well as Oklahoma, Arkansas and Louisiana.

EAGLE
TIME DELAY RELAY



WITH COMPACTNESS — PLUS "MIL-SPEC" 2000 cps VIBRATION TESTS

SPECIFICATIONS (General)

a. Operates during 5 to 2000 cps, 10G vibration.
b. Operates −55° to +125° C.
c. Withstands 30G 11ms shock.
d. Weight 9 oz.
e. Hermetically sealed.
f. D.C. operating coil.
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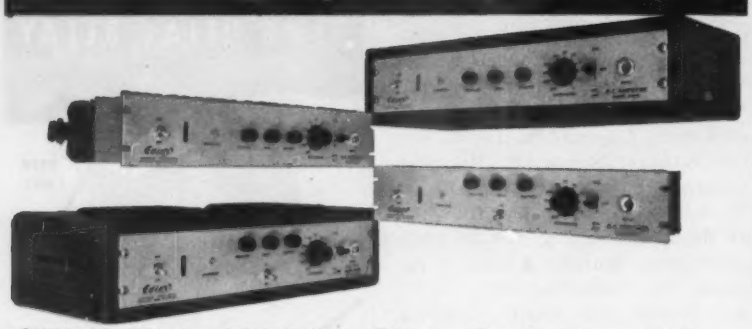

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COMMENT

No Johnny-Come-Lately

That was a nice roundup on digital computers striking oil ("Digital Computers Strike Oil," p 20, Jan. 23). I'm sorry to mention, however, that there's an error you might consider correcting in whatever way you think appropriate.

The caption (on the lead illustration) says our IBM704 was "installed last month." Actually it was in November and December of 1957.

The only trouble with this otherwise understandable slip is that it makes the company look like a Johnny-come-lately instead of a pioneer in the field.

R. L. DUNNE
ESSO RESEARCH & ENGINEERING CO.
NEW YORK

Tolerance

(Re "Thin Parts Produced by Etching," p 74, Jan. 30: "A tolerance of ± 0.002 inch is not difficult to hold on material of 0.001 to 0.005 inch thickness. . .") This is a good trick if you can do it. Or is it a new form of the old-fashioned "puttenon" tool?

W. L. WRIGHT
WRIGHT RADIO CO.
SCITUATE HARBOR, MASS.

We've been away from New England long enough to have forgotten what a puttenon tool is, but we can vouch for the reasonableness of the tolerance figure. The tolerances are those which can be held in length, width or diameter of the parts; there is no reduction in thickness of the metal sheet, since the resist protects its surface from the etchant.

Of course, once the etchant has removed the top surface of the metal, it can work sideways under the resist. The thicker the metal sheet, the greater the amount of undercutting that can occur.

Of Praise and Glory

(Re: Comment, p 103, Feb. 6, letter captioned "Kudo") . . . The

singlar is *kudos* from the Greek meaning *praise, honor* . . .

WILLIAM J. TEMPLE
BROOKLYN COLLEGE
BROOKLYN, N. Y.

Reader Temple—who is professor of speech at Brooklyn College—catches us in an error for which we can offer only this rationalization: that we've always been entranced by the idea of a singular kudo. The Greek word, incidentally, means "glory."

And we guess that if we're to be called on this, we must henceforward use the Greek plural "kudoi."

Theodolites

We were very pleased to see the prominent attention you gave to the azimuth alignment theodolites ("Theodolite References Jupiter Guidance," p 62, Feb. 6), and to their important role in helping ensure the accuracy of long-range missiles.

There is one additional point that deserves mention. The particular theodolites we produce for the Jupiter were developed jointly with the Army Ballistic Missile Agency at Redstone Arsenal. The group there, under Walter Haussermann, Fritz Mueller and Henry Rothe, were responsible for, and deserve credit for, the overall alignment system development. Our responsibility was to develop and produce instruments to meet the highly precise requirements of that system.

Unfortunately there was an oversight in noting this among the several credits when we originally prepared the material and had it cleared through the appropriate agencies.

CARLTON W. MILLER
PERKIN-ELMER CORP.
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Always happy to give credit where due.

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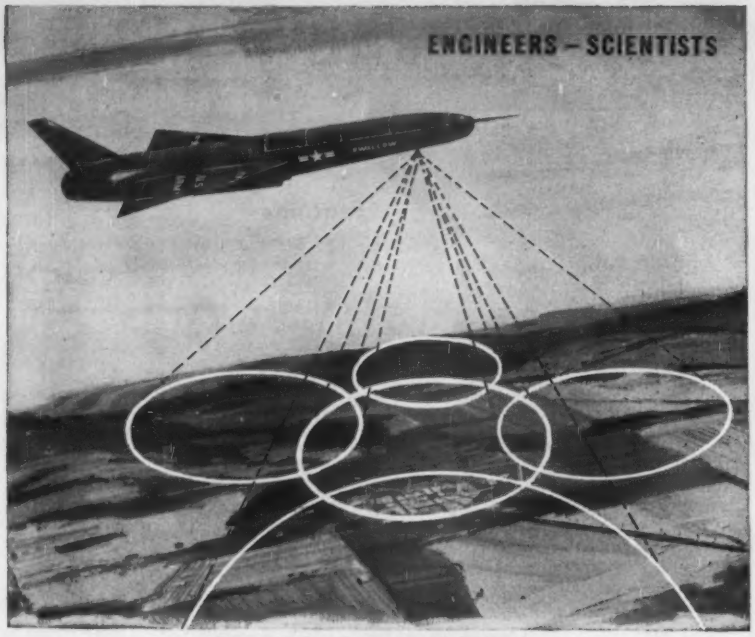

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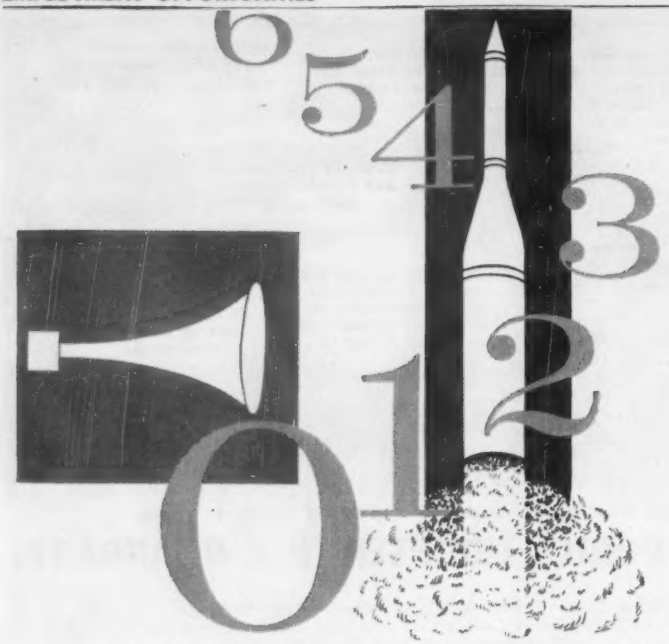

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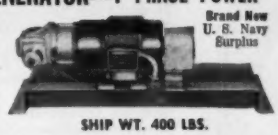

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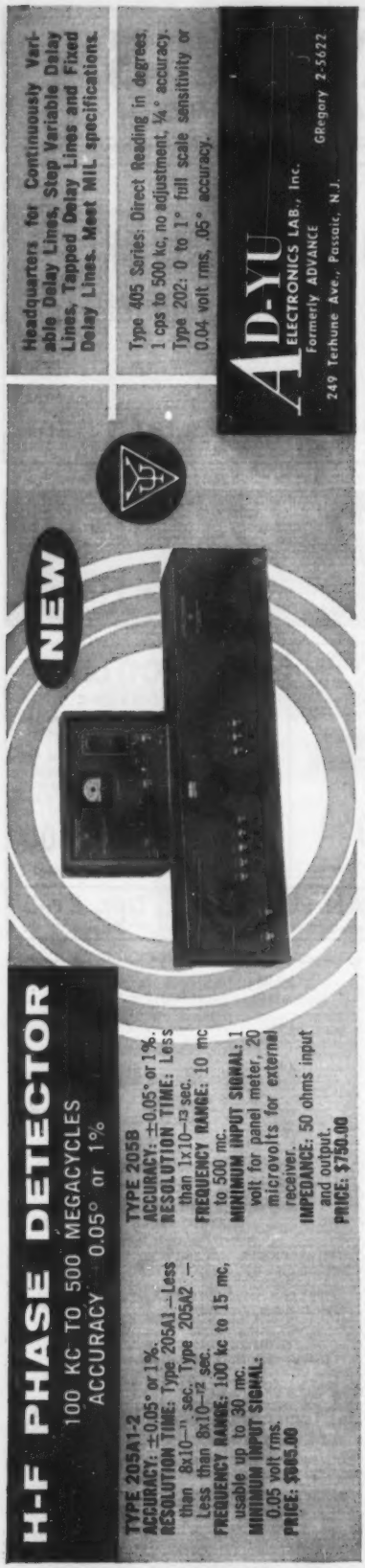
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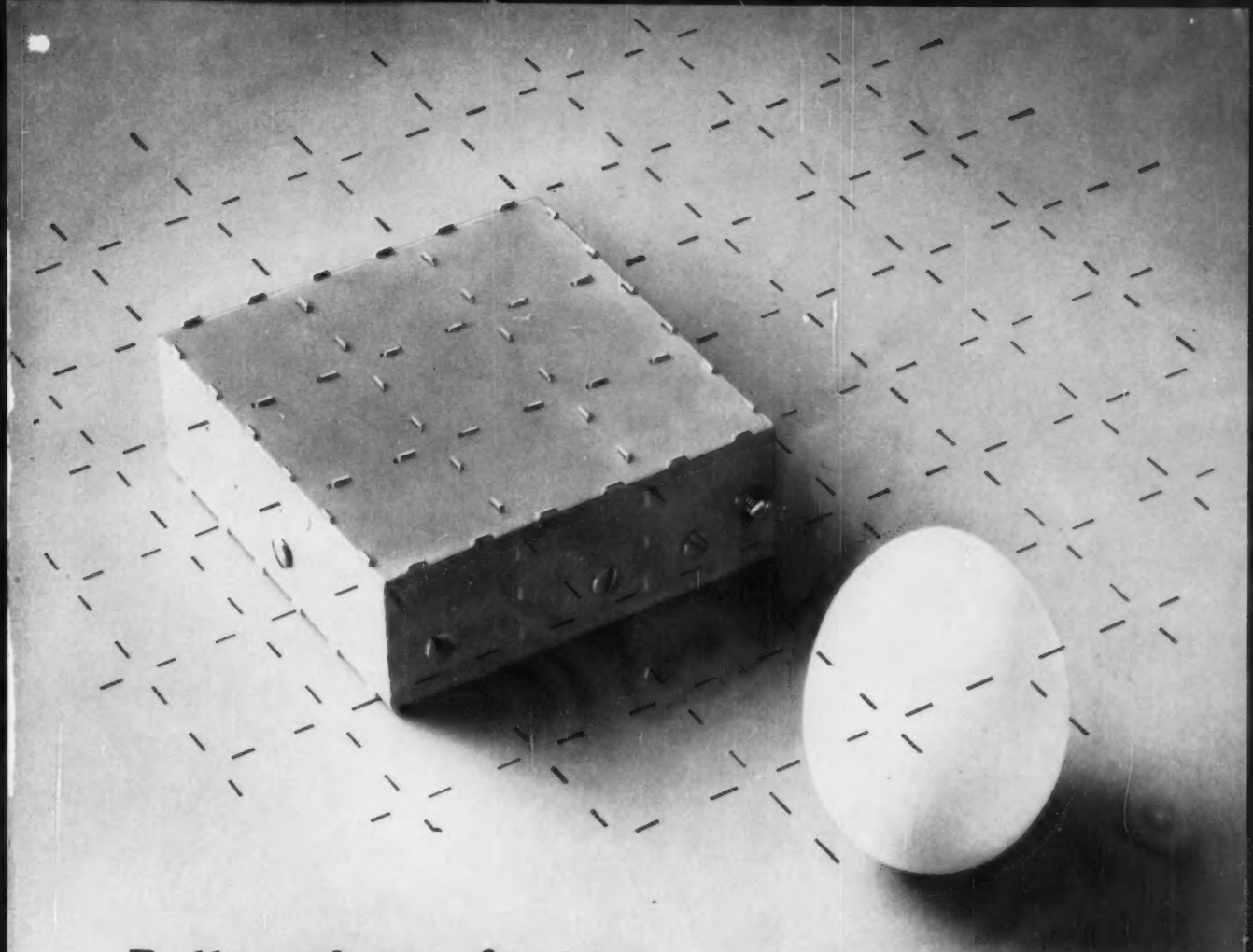

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